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THE

PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

HONORARY MEMBER OF THE ROYAL IRISH ACADEMY, &c. &c. &c.

"Nec aranearum ſane textus ideo melior, quia ex ſe fila gignunt. Nec noſter vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

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FIFTEENTH VOLUME.

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THE
PHILOSOPHICAL MAGAZINE.

I. *On Indian Dogs. By Dr.* BARTON, *of Philadelphia* *.

IT would require much obfervation, many experiments, and a great deal of time, to collect all the neceffary materials for an exact hiftory of the native dogs of North America. I am by no means prepared for the ample tafk. My object, in the prefent article, is much more limited—to bring together a number of fcattered facts relative to the origin and manners of the different kinds of dogs which were found among the Indians when the Europeans firft took poffeffion of the countries of North America. In the inveftigation of this inquiry I cannot pretend to be very methodical: nor do I expect to avoid errors. I aim, however, at correcting fome of the errors of preceding writers.

It has been afferted, by many hiftorians and naturalifts, that there were no dogs in America prior to the difcovery of this portion of the world by the Europeans †. Mr. Pennant, one of thefe naturalifts, remarks: "As it is certain that the dog of North America, or rather its fubftitute, on its firft difcovery by the Englifh, was derived from the wolf tamed and domefticated, fo it is reafonable to imagine that of South America had the fame origin ‡." I do not think it fufficiently afcertained that there were not originally in America any fpecies of dog of the fame ftock as thofe of the old world. It has not yet been proved, that the dog of Newfoundland, of which I am afterwards to make more particular mention, was unknown in that ifland before its difcovery by the Europeans. But admitting that the Newfoundland fpecies or variety originated from an admixture of the European dog with the wolf, or fome other native animal of the country, it will ftill appear fomewhat probable, that the Indian dogs in many other parts of America were not *fpecifically* different

* Communicated by the Author.

† Acofta, Gomara, Herrera, Joannes Fabri, Buffon, Pennant, &c. &c.

‡ Hiftory of Quadrupeds, vol. i. p. 237.

from those of the old world. This question is well worthy of the attention of the naturalist, and is even entitled to the notice of the civil historian of the new world.

Techichi, or Alco.

In Mexico and in South America there was a small species of dog, which the Mexicans called *techichi*, and the Peruvians *allco*, or *alco*. This is particularly mentioned by the jesuit Joseph Acosta *, and other of the earlier visitors of America. The *alco* had a melancholy aspect, and was perfectly mute, or dumb. Hernandez speaks of it as being similar in nature and manners to the common dogs of Europe, and not very different in form †. It is remarkable that Linnæus has taken no notice of this species, though he so frequently refers to the work of Hernandez. Mr. de Buffon has confounded it with the *itzcuintepotzotli*, or next species, from which, however, it appears to have been distinct ‡. Gmelin, who has fallen into a similar mistake (though the words of Hernandez are sufficiently plain), considers the *alco* as a variety of the canis familiaris, or faithful dog. He calls it canis familiaris, Americanus. Although I have little doubt that the *alco* was a true canis §, I think it is too slightly mentioned or described to enable us to determine, with as much certainty as the naturalist could wish, whether it was merely a variety of the common dog, or an entirely distinct species. It is to be regretted, indeed, that the naturalists who visited America in the sixteenth century, whilst the alco was still a common animal, have left us so much in the dark concerning its origin and nature. Owing to their negligence, we are, at this distance of time, only permitted to say, with some degree of probability, what it was not. I do not, with Mr. Pennant, think it probable that it was derived from the wolf. Its entire muteness is, I think, greatly opposed to this idea;

* The Naturall and Morall Historie of the East and West Indies, &c. p. 301, 302. English translation. London 1604.

† Historiæ Animalium et Mineralium Novæ Hispaniæ Liber Unicus, &c. p. 6, 7.

‡ Histoire Naturelle, &c. tom. xxx. p. 200, &c.

§ Independent of the testimony of Hernandez, there would seem to be very little doubt that the *alco* was a true species of canis, and, indeed, very similar to some of our small house-dogs. The Spaniards, according to Clavigero, gave it the name of *perro*, which signifies a dog; and Acosta observes, that the Indians called all the dogs which were brought from Spain *alco*, from the resemblance between them and their native animal. It is probable that the Indians in some parts of South America had afterwards (perhaps when the *alco* became either very rare, or extinct) adopted the Spanish word *pero* for dog. The Jaioi, in Guiana, used this word at least as early as 1633. De Laet's Novus Orbis, p. 643.

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as is alſo, perhaps, its complete domeſtication. If it were immediately derived from the wolf, we ought, at leaſt, to allow the Americans ſome ſhare of merit for the ſucceſsful pains they had taken to reclaim this animal from the wild ferocity of his nature.

This ſpecies or variety of dog appears to have been pretty extenſively diffuſed through the ſouthern parts of the continent of America, and certainly exiſted in ſome of the iſlands when they were firſt diſcovered by Columbus. Peter Martyr, and after him other hiſtorians, mention the diſcovery of mute little dogs in the iſland of Juanna in the year 1492. Martyr ſays they were deformed in ſhape, and that the ſavages ate of them as the Europeans did of goats*. I cannot find that this ſpecies was diſcovered among any of the Indian tribes inhabiting the tract of country now called the United States. It is not certain, indeed, that the dogs which Soto found in Florida were not of the alco kind: I think it highly probable, however, that they were not, but that they were much more allied to the wolf and fox, like the modern Creek dogs, which I am afterwards to mention.

It would appear from Clavigero, that the alco is now entirely extinct. "After the conqueſt of Mexico," ſays this author, "the Spaniards, having neither large cattle nor ſheep, provided their markets with this quadruped; by which means the ſpecies was ſoon extinct, although it had been very numerous †."

Itzcuintepotzotli.

The *itzcuintepotzotli* was the Mexican name for another ſpecies or variety of dog, which is figured and deſcribed by Fabri ‡ and by Clavigero, whoſe figure is borrowed from that of the Italian naturaliſt. If the figure be an accurate one, the animal muſt have been of a very deformed aſpect; and as ſuch, indeed, it is deſcribed. It was about the ſize of a Malteſan dog, or rather larger. The head was very ſmall, the ears pendulous, and the eyes ſoft and pleaſing. The noſe had a conſiderable prominence in the middle, and its tail was very ſmall. But the moſt ſtriking feature of the animal was a protuberance upon its back, not unlike that upon the Arabian camel. The ſkin was varied with white, tawny, and black.

This ſpecies particularly abounded in the kingdom of Mi-

* The Decades of the Newe Worlde or Weſt India, &c. The firſt decade, p. 15. Engliſh tranſlation. London 1555. 4to.

† The Hiſtory of Mexico, vol. i. p. 40.

‡ Rerum Medicarum Novæ Hiſpaniæ Theſaurus, &c. p. 466, &c.

 chuacan,

chuacan, the moſt weſterly part of the old empire of Anahuac. The natives of Michuacan called it *abora*, or *aborc*. It is ſaid, by Clavigero, to be almoſt wholly extinct *.

The *itzcuintepotzotli* bears no reſemblance whatever to the wolf, from which it is not probable that it was derived. It has much more the aſpect of ſome of the domeſticated dogs; and Hernàndez informs us, that it reſembled them in nature and in manners. That it was a ſpecies of canis is very probable; but that it was a mere variety of the common dog is much more uncertain. I rather ſuſpect it was not. We are not, indeed, permitted to decide this matter with certainty. One eſſential difference between the two animals we are able to collect: the Mexican dog is ſaid to have ſix teats, whereas the common dog has ten.

Buffon, Pennant, and Gmelin, have confounded this animal with the *alco*. Hernandez, however, plainly ſpeaks of them as two diſtinct animals †; as does alſo the abbé Clavigero ‡. It is probable, however, that they were conſiderably allied to each other.

Either this ſpecies or the *techichi*, perhaps both, were brought to the market of the city of Mexico, along with deer, rabbits, and many other animals, before the conqueſt of the Spaniards. Gage ſays theſe animals were ſold either "by quarters or whole." It would appear from the ſame writer, that theſe dogs were ſometimes caſtrated for food §. Theſe ſimple facts are calculated, with many others, to ſhow that the Mexicans, at the time they were diſcovered, had actually advanced, in many reſpects, towards the attainment of that police, thoſe arts and practices, which are never obſerved among people in the ſavage forms of ſociety. Another century, but for the diſcovery of Columbus, would have conducted theſe unfortunate Americans much nearer to the condition of their conquerors; but it is to be feared that many centuries would have been requiſite to have weaned them from their hideous religion, which was the foundation of their ſavage practices and manners. The hiſtory of mankind exhibits abundant proofs of this poſition, that the arts which they practiſe, and the police which they obſerve, are no certain evidences of a truly civilized ſtate. A mild religion appears to be abſolutely neceſſary to the attainment and the preſervation of this happy ſtate of man.

* The Hiſtory of Mexico, vol. i. p. 44.
† Hiſtoriæ Animalium, &c. Liber Unicus, p. 7.
‡ The Hiſtory of Mexico, vol. ii. p. 382 and p. 323.
§ A New Survey, &c. p. 111.

Wolf

Wolf Dogs.

We know not whether the *techichi* and the *itzcuintepotzotli* were found in any of the countries confiderably to the north of Mexico. We are well affured, however, that different kinds of dogs were very common in many of the countries of North America, when this continent was firft difcovered by the Europeans, in the 16th and 17th centuries. I am even inclined to think that North America was much better fupplied with dogs (I mean thefe animals in the domefticated ftate) than South America and Mexico. There feems to be little doubt that in the northern countries there was a greater variety than in the fouthern countries. Florida abounded in thefe animals. When Fernando de Soto marched his army through that country, in the year 1540, the Indians fupplied him with great numbers of dogs. On one occafion, an Indian cacique fent the Spanifh general no lefs than three hundred dogs *. Thefe were eaten by the Spaniards, who deemed them not inferior to the beft of fheep †. But we are informed that the Indians did not eat them ‡. It would feem that the Spaniards did not always ftand upon the ceremony of waiting to have the dogs prefented to them. The Portuguefe author of Elvas, who accompanied Soto and his fucceffor in their mad ramble, informs us, that, during the time the army laboured under a fcarcity of meat, "he who could catch a dog in any village thought himfelf a very happy man; for fometimes (he obferves) we found thirty in a place; but the foldier that killed one, and fent not a quarter to his captain, fuffered for it, paying dear for his incivilities when he was to go fentinel, or upon any guard of fatigue §."

We are not told what kind of dog it was that the Spaniards

* This was the cacique of Quaxule, which, if we can depend upon the old maps of Florida, was in the country of the Chikkafah Indians. A Relation of the Invafion and Conqueft of Florida, &c. &c. p. 71.

† See A Relation, &c. p. 55.

‡ A Relation, &c. p. 71. I do not think it certain that the Indians did not eat their dogs. The prefent which Soto received at Ocute, in the country of the Creek Indians, rather favours the opinion that they did. The cacique fent the Spanifh general "two thoufand Indians, with a prefent of rabbets, partridges, maes-bread, two pullets, and a great many dogs." A Relation, &c. p. 55. If the Indians did not eat their dogs, why did they fuppofe the Spaniards were fond of them? It is true, there was a great fcarcity of meat and falt at Ocute, and the Indians may have fuppofed that any kind of food would be acceptable to an army of hungry men. Befides, it is probable they had many opportunities of feeing the Spaniards employed in ftealing their dogs.

§ A Relation, &c. p. 56.

found among thefe Indians. There do not appear to be good grounds to fufpect that they were of the *alco* or *itzcuintepotzotli* kinds. It is certain that neither of thefe animals is now known among any of the Floridian Indians; and it does not feem likely that the breeds which thefe Indians at prefent poffefs have been reclaimed from the wild ftate fince the time of Soto's "mad adventures."

The dogs which are now in ufe among the Creeks, Chikkafah, and other fouthern tribes, are of different kinds. As far as I have been able to collect information concerning them, they, in general, bear a very ftrong family refemblance to the wolf. One kind is very fimilar to the *canis lycaon*, or black wolf, of which I have already made mention. It is not, however, always black, but of different colours, commonly of a bay colour, and about one-third lefs than the wild black wolf. It carries its ears almoft erect, and has the fame wild and fly look that the wolf has *.

The other kind of dog is fmaller than the one juft mentioned, and is more like the common red fox. Both kinds bark, but not fo much as the common dogs; and their bark is different from that of our dogs, being more nearly allied to the howl of the wolf †.

I am unable to fay, with certainty, whether thefe fouthern dogs differ very effentially from thofe among the northern Indians. I rather fuppofe they do not. I know, at leaft, that among the latter, as well as among the former, there are two fpecies or varieties; one which has generally been confidered as the wolf merely altered by the domefticated ftate, and the other more allied to the fox. But as my information concerning the northern dog is more correct and particular than it is concerning the fouthern, I wifh to be underftood as fpeaking principally of the former, in the following defcription of the Indian dogs.

The Indian dog (I mean that which is moft allied to the wolf) is frequently called, by the traders and others, *the half-wolf breed*. His general afpect is much more that of the wolf than of the common domefticated dogs. His body, in general, is more flender than that of our dogs. He is remarkably fmall behind. His ears do not hang like thofe of

* From the information of Mr. William Bartram.

† I have been informed, that among the Cheerake Indians the dogs are of a more mixed breed, more like thofe of the whites. This is doubtlefs owing to the greater intercourfe which has fubfifted between thefe Indians and the whites. The Cherakee themfelves are fo much mixed with the Europeans that they are often named by the traders, the "Breeds."

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our dogs, but ſtand erect, and are large and ſharp-pointed. He has a long ſmall ſnout, and very ſharp noſe *. His barking is more like the howling of the wolf. When attacked, and when fighting, he does not ſhake his antagoniſt, like our dogs. His teeth are very ſharp, and his bite ſure. When he ſnarls, which he is wont to do upon the ſlighteſt occaſion, he draws the ſkin from his mouth back, preſenting all his teeth to view. Our dogs, when once attacked by theſe Indian dogs, always fear and ſhun them. It is a very curious circumſtance, that the Indian dog will never attack or purſue the wolf, which the common dogs ſo readily do. This fact ſeems to point very ſtrongly to the origin of the American animal. For the purpoſes of hunting, the Indian dogs are very uſeful; but, in other reſpects, they are by no means ſo docile as the common dogs. They have leſs fidelity; for, though never ſo well fed, they will ſteal from their maſters †. In ſhort, every thing ſhows that the Indian dog is a much more ſavage or imperfectly reclaimed animal than the common dog.

If my information has been correct, this ſpecies or breed is ſtill preſerved in the greateſt purity among the Six Nations, from whom the Delawares acknowledge that they received it. The Delawares call this dog *lenchum*, or *lenni-chum*, which ſignifies "the original beaſt." The Nanticokes call him *ihn-wâllum*; the Mahicans, *annuñ-neen-dee-a-oo*, or "the original dog," to diſtinguiſh him from our common dogs, which they call ſimply *dee-a-oo*, or *de-a-oo*.

Theſe appellations ſhow that the Indians conſider their wolf dog as a native of the country, and that they are not incapable of diſcerning the differences between this animal and the greater number of the varieties of dogs which have been introduced into America by the Europeans.

The origin of the Indian dog is a queſtion of much more difficulty than ſome naturaliſts have imagined. Thus, Mr. Lawſon ſeems to ſuppoſe that the dogs which he ſaw among the Indians of North Carolina were merely wolves, "made tame with ſtarving and beating ‡." This is eaſy natural hiſtory. Mr. Pennant, as we have already ſeen, ſuppoſed that the dog of North America was derived from the wolf, tamed

* Some perſons inform me, that many of the Indian dogs have a large white ſpot upon the breaſt.

† This aſſertion, I muſt confeſs, is oppoſed by the teſtimony of ſome writers. Thus Carver ſays, the Indian dogs are "remarkable for their fidelity to their maſters; but, being ill fed by them, are very troubleſome in their huts or tents." Travels, &c. p. 416.

‡ A New Voyage, &c. p. 38.

and domesticated *. This opinion has been maintained by other writers; but it is an opinion which must be admitted with some limitation. I am, indeed, much inclined to believe that the Indian dog, in many parts of North America, was derived from the wolf; but it remains to be proved that it is, in any part of the continent, the pure or unmixed wolf, in a state of domestication. It is, more probably, an hybrid animal, begotten between the wolf and some other animal, perhaps the fox. Mr. Josselyn, a long time ago, considered the dog of the New-England Indians as the produce of the wolf and fox †. This is also the opinion of many well-informed persons who have resided among, or visited, the Indians. I believe it is the opinion which many of the Indians themselves entertain concerning the origin of their dog.

I have already observed that the Indian dog is sometimes called *the half-wolf breed*. This plainly shows that those who have imposed this name did not view the American dog as a mere domesticated wolf. In other words, it shows that they considered him as an hybrid animal. I may add, that Carver and other writers, who have enjoyed pretty extensive opportunities of observing the dogs of the Indians, merely speak of their resemblance to the wolf, without pretending to assert that they are only domesticated wolves ‡.

Owing, however, to the great affinity which subsists between the Indian dog and the wolf, the savages in some parts of North America bestowed the same name upon both of these animals. Thus father Hennepin expressly informs us, that *chonga* is a dog or wolf, in the language of the Issati and Naudowessies. In general, however, the Indians apply different names to the wolf and to the dog, whether it be their own (or native) dog, or those varieties which they have received from the whites. I may add, that the Indians seem also to have remarked the resemblance of some of their dogs to the fox; for the Mohawks (or at least the Cochnewagoes, who have sprung from the Mohawks) call the red fox *cheets-hoo*. Now the Tuscaroras, who speak a dialect of the language of the Mohawks, call a dog *cheeth* and *cheetht*. Much dependence, however, should not be placed upon this application of names; for savages sometimes bestow the same names upon species that are unquestionably distinct.

* See p. 1.

† "The Indian dog is a creature begotten betwixt a wolf and a fox, which the Indians lighting upon, bring up to hunt the deer with." Josselyn's New England's Rarities, &c. p. 13.

‡ "The dogs employed by the Indians in hunting appear to be all of the same species; they carry their ears erect, and greatly resemble a wolf about the head." These are Carver's words. See his Travels, &c. p. 416.

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We are not yet prepared, it is obvious, to give an exact genealogical history of the Indian dog. We are compelled to mix conjecture with fact. The anatomical structure of the animal should be examined. But, whatever may have been the origin of this breed of dogs, I am disposed to think, with Josselyn, that the savages found it in the woods, and that it has existed as a distinct species, or breed, for a very long period of time. Several of the earlier visitors of different parts of North America speak of the existence of wild dogs in the country. Renatus Laudonerius invaded Florida in the year 1564, only a few years after the death of Soto. In his enumeration of the native productions of the country he mentions wild dogs. There is no reason to suppose that he has confounded them with the wolves: for he expressly says that the country produced, beside these dogs, some species of wolves *.

The discoverers of the island of Cape Breton, in the Gulf of St. Lawrence, found in that island black dogs, which, we are informed, the Indians were very careful to bring up to hunting †. I think it probable that both these and the dogs mentioned by Laudonerius were the same as the half-wolf breed which I have described.

[To be continued.]

II. *An Account of a new Method of supplying Diving-bells with fresh Air.* *By* ROBERT HEALY, *A.B.*

To Mr. Tilloch.

Dublin, Jan. 8, 1803,
43, James's-street.

SIR,

I TAKE the liberty of communicating an experiment on diving, which was made last August by my father, Mr. Samuel Healy. Should it appear worthy of holding a place in your very useful and instructive Magazine, you are at full liberty to insert it. ROBERT HEALY.

THE method of supplying a diving-bell with air, which has hitherto been generally adopted, renders it almost impracticable either to descend in water to any considerable depth, or to remain there a length of time sufficient to perform any thing useful. Much inconvenience results from the attention which it is necessary to pay in admitting the supply from the barrels, which are used as reservoirs of air; much also from

* See De Laet's Novus Orbis, lib. iv. p. 215.

† See the same, lib. ii. p. 37.

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the labour and time which are expended in causing them to reach the bell. The mode of supply which Mr. Healy contrived appears much calculated to remedy these inconveniences. A recital of the circumstances that attended Mr. Healy's experiment, it is hoped, will not prove uninteresting.

Captain Lonsdale, of the Experiment, was employed to raise a brig which had foundered, in the year 1799, in the Bay of Dublin, between Dunleary and Howth. This he endeavoured to accomplish by fastening chains round the bow and stern of the sunken vessel, and by connecting to these a ring on each side, through which cables passed, and were lashed at low water across the deck of his ship, that acted as a buoy. Consequently, on the tide rising, if the fastenings had not given way, the floating vessel must either have sunk itself, or drawn the other upwards.

Mr. Healy accompanied captain Lonsdale in this attempt, in order to put in practice his mode of supplying a diving-bell with air. The bell, which resembled a truncated cone, was made of wood, consisting of staves united by cooperage: the mouth was two feet and a half in diameter; the top one foot and a half: the height was four feet. Windows were placed at proper distances round the sides, and one at the top: there was also an aperture in the top for letting out foul air. In the inside was suspended a stage for the purpose of resting on. On the top was fixed an iron eye, through which a cable passed for raising or lowering the bell. This eye was secured to the bell by four iron bars, of an inch square, that went down the sides and lapped under its edges. Within six inches of the bottom was fixed a broad iron hoop, of an inch thickness, from which weights were suspended to sink the bell.

On the ship's deck was lashed a forcing or condensing syringe, capable of containing about two quarts, to which were connected five fathom of iron tube, and to the end of this an equal length of leathern tube that turned into the bell. When the piston was depressed, the contained air passed through the tubes, and was forced into the bell. Thus a constant stream of air was forced down.

Four hundred weight and a half being suspended in the manner described, Mr. Healy was first let down rapidly, when, on signifying his desire of ascending, his wish was immediately complied with. He stated, that great uneasiness was felt, particularly in his ears, from such a sudden descent; that there was sufficient light in the bell to enable him to read by light reflected through the mouth of the bell without removing the shutters of any of the windows; and also that

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he could ſee a good way down in the water. Having reſted a few minutes, and matters being arranged more ſatisfactorily, he was lowered gradually, and remained ſtationary about a minute at each fathom's depth; the ſyringe ſupplying ſuch a conſtant ſtream of air, that the bell was ſupercharged, and the ſignal of ſufficiency was often repeated. Having been more than half an hour down, and for ſome time on the deck of the ſunken veſſel, he gave the ſignal for aſcending, and was drawn up in the ſame gradual manner in which he had been let down.

He ſaid, that the very inſtant the mouth of the bell was immerſed a noiſe ſtruck his ears, which went off upon his reſting at the diſtance of a fathom from the ſurface: the next deſcent cauſed the ſame deafening ſenſation, the removal of which was effected, to a conſiderable degree, by repeated yawnings. No inconvenience was felt by his reſpiring air condenſed by the preſſure of ſix or ſeven fathoms water. A ſlight giddineſs remained a few minutes after his emerging, and the blood-veſſels about his face were a little ſwollen.

In the night, the laſhings having given way at high water, one of the rings through which the cables paſſed fell to the bottom. On the following day he deſcended, in a gradual manner as before, to the depth of ſeven fathoms, in order to raiſe the ring, and remained below for an hour and ſome minutes. Not the ſmalleſt inconvenience was felt in his breathing. After coming up he coughed, and a ſlight tinge of blood appeared in his ſpittle. The fullneſs in his face, as alſo the giddineſs, occurred as in the laſt experiment. In this the bell did not appear to admit ſo much light as in the former experiment, although the papers explanatory of the communication of ſignals by pulling the ropes (which, for precaution, were fixed to the inſide of the bell) were ſtill legible. With the ſyringe one man ſupplied ſeven gallons of air in a minute, and, if neceſſary, could have ſupplied double that quantity.

The following morning the wind roſe to ſuch a degree as to break both the cables and chains that were attached to the ſunken ſhip, and of courſe interrupted the proſecution of further experiments; which, however, at a future period, Mr. Healy hopes to reſume. It is to be wiſhed that other adventurers will make ſimilar attempts, and improve on the hint which this trial affords; for, to uſe the words of Seneca,

Patet omnibus ars, nondum eſt occupata, multum ex illâ etiam futuris relictum eſt.

III. *On*

III. *On Painting.* *By Mr.* E. Dayes, *Painter.*

Essay VIII.

On Manner.

Peculiar marks I hold to be generally, if not always, defects; however difficult it may be wholly to escape them. *Sir Joshua Reynolds.*

THE word *manner* may be applied to colour, light and shade, and penciling. It is expressive of certain peculiar marks that invariably characterize the works of each individual, as in some a blueness in the colouring prevails, in others a gray or yellow, while others are distinguished by a harshness in the shadows; in one the penciling is round, in another square or forked. So far is a new manner from being a mark of genius, as some assert, that, could perfection in painting ever be attained, it would be unaccompanied by any peculiarity whatever.

In that part of our education which is to be obtained by copying, we ought to be particularly careful that the works we copy, or the master we imitate, have a manner the purest and the least vicious possible; for we may rest assured, singularity, which in some is glaringly absurd, will be the first portion we shall inherit.

He who forms to himself a model in a master will be always inferior to the archetype: the heads of all the great schools have been superior to their imitators. Nature rises in the same degree over the servile and base. M. Angelo was superior to his disciples, and that in proportion to their dependent habit of thinking. The same cause placed Raphael, Titian, the Caracci, &c. at the head of certain classes of artists, many of whom have followed their masters limpingly and awkwardly. The same baneful desire of imitation is equally detrimental to poets; for the arts cannot be called liberal in the hands of those who want spirit to think for themselves. Not to acknowledge the favours we receive would we illiberal, but to sink under them into a state of slavery is base. The wisdom of the world may inform, but we must improve from ourselves; for precept will do but little if the mind is not susceptible of it; the seed must be suited to the soil. The mind, like a fine spring of water, will become more productive and clear the more it is used.

Peculiarity is what chiefly characterizes the different masters. We say, for instance, the manner of Raphael is dry

and hard, thereby indicating the too violent diſplay of outline, the deciſions and abrupt diviſions in the ſhadows, with the parts not ſufficiently loſt in their grounds. That of Spagniolet is forcible, with much red in the fleſh; while in that of Rembrandt we expect little light, with a glow of colour, that may too often be called rotten-ripe. We may further obſerve the dark manner of Guercino and the ſilver of Guido, with many others not neceſſary to mention. What are thoſe differences in the various maſters, but ſo many ſingularities that characterize and diſtinguiſh the individual?

As perfection cannot be attained, every artiſt, of neceſſity, will have a manner; but in proportion as he ſucceeds in approaching perfection will his manner become the more pure. This he can only hope to attain by an extenſive inquiry, that is, by not ſlaviſhly tying himſelf down to the imitation of an individual. He is bound to ſhow in his works that he has opinions of his own, and that he dares to think for himſelf.

Raphael's firſt manner was like that of his maſter Perugino; but this he ſoon quitted for a ſweeter mode of colour, which he caught from Da Vinci and Bartolomeo, and for a more noble and elevated ſtyle, which he acquired from M. Angelo. Julio Romano imbibed much of the fire of his maſter, as did Roſſo and Prematicio of theirs. The Caracci adopted a moſt liberal manner of imitation, founded on a combination of the excellences of all the great ſchools, and ultimately produced one entirely new. Domenichino, Guido, Guercino, and Schidone, exhibit in their works but ſlight traces of the ſchool they were formed in. Van Dyck is perfectly original. Our countryman Reynolds is an example of this liberal manner of imitation; we ſee in his works the grace of Corregio and Parmegiano combined with the beauty and richneſs of Venetian colouring, accompanied with the *chiaro-ſcuro* of the Flemiſh and Dutch. Le Sueur's firſt manner reſembled his maſter Vouet, which he ſoon quitted, and made himſelf ſuperior in every part of the art. Le Brun was influenced by the ſame ſpirit of independence, and left his maſter far behind.

Of thoſe who have been deſtitute of the pride of independence, and have fallen into a narrow, confined, and illiberal kind of imitation, we will point out a few. Guido was imitated by Sirani, Pouſſin by Verdier, Paul Veroneſe by his brothers, and Jacomo Baſſan by his ſons. Rubens was imitated by Jacques Jordans, who has increaſed the exceſſes of his maſter without adding one perfection of his own. Rembrandt was followed ſervilely by Bramer, Eckhout, De Gelder, &c. We might enumerate many others, which muſt occur

to

to every one's recollection, whose works pass with the ignorant for those of their masters. Perhaps this difference in the works of artists may arise from the external objects and their images painted in the eye of some, not agreeing; which may also account for the variation we observe between the bulk or altitude of bodies and their representations by various artists. This peculiar habit of seeing may constitute what we call manner.

It is certain too much copying, or too great a devotion to the works of some favourite master, brings on a habit of seeing even nature with his imperfections. Hence it is, that what is termed the schools have in the end proved the ruin of art; not because they were bad, but because weak men have been content with nature at second-hand: some author calls such people not nature's sons, but her grandsons.

Before we quit this part of our essay we will just touch on the manner of penciling, also called handling. The use of the pencil is distinguished into the smooth or mellow, and the expeditious or bold. The application of those manners must, in a great degree, depend on the size of the picture to be painted, also its situation and subject. As far as subject is concerned, the former method best applies to objects in themselves beautiful; as elegant female figures, young and sleek animals, pastoral, and all objects intended to delight. The latter manner will best associate with aged, broken, and irregular objects, and such scenes as are intended to excite terrible emotions. The bold pencil of Rubens is highly admirable, and is a great beauty in his pictures; while the pencil of Van Dyck is more soft and mellow. Claude had a smooth pencil suiting his choice of subject; on the contrary, Salvator Rosa is bold, and well impasted with colour. The pencil of Titian is a fine example for the heroic in landscape, or what may be termed the historical style, and which, as mentioned in our first essay, derives its name from the dignity of the objects of which the picture is composed. Those are mistaken who imagine it derives its character from slightness and indecision, and who dignify their own crude and undistinguishable masses with that noble appellation. The pencil of Titian is firm, bold, and at the same time decisive, and, in the higher style of landscape, may be offered as an example worthy of our attention. We shall find numberless examples in the Dutch school to direct our hand in the pastoral; and the pencil of young Teniers is, perhaps, the finest in that part of the art. The pencil is not a mere vehicle for laying on the colour, but its motion must express the character of the various objects it may be employed on. As in

landſcape the foliage of trees, incruſting of the bark; on cattle, in repreſenting hair and wool; the character and folds of drapery, the thinneſs of flowers, &c. &c.

As well as the manual practice, painting requires, 1. A boldneſs of hand in the dead-colouring: 2. In the ſecond colouring, more circumſpection and labour: and, 3. Thorough patience and attention in the retouching and finiſhing of the picture. Theſe qualities can no more be ſeparated than Venus and the Graces.

He who wiſhes to inſure himſelf a good manner of penciling ſhould avoid copying ſuch pictures as are imperfect in that reſpect; for, if we begin with a ſlovenly or bad one, every ſtep will plunge us deeper in error. But all attempts at painting will be vain if we do not poſſeſs the power to determine the form at once, which can only be acquired through a previous practice in drawing; for on this the clearneſs as well as the firmneſs of the penciling depends.

There are two methods of preparing our picture: one is, to draw in the objects with their ground colour, carefully laying in the ſhadows, dead-colouring the lights ſolid, and *preſerving the ſhadows tranſparent throughout the work*; in the ſecond ſtage, to correct the forms, and add to the darks where wanted; and, thirdly, after oiling out the parts, bringing the whole into harmony by glazing, ſcumbling, and finiſhing with the extreme lights and darks. This direction is general; for, after the lights and darks are added, parts may require to be kept down, enriched, &c., as practice muſt direct. The ſecond method is to dead-colour *ſolidly throughout*, and to finiſh the ſhadows by glazing. The latter method admits of greater changes being made in the work during its progreſs than the former.

*** In our laſt Eſſay, for W. Scope, read W. Scrope, eſq. of Caſtle Comb.

IV. *Experiments on the Colouring and Mordant Property of the Oxide of Molybdena.* *By* M. D. Jaeger*.

THESE experiments were made with foliated molybdena of Altenberg, in Saxony, prepared in the following manner:

After having ſeparated the metal from all quartzy parts, it was reduced into an acid by long expoſure to a red heat in an open crucible. This acid was then diſſolved in boiling water,

* From Scherer's *Allgemeines Journal der Chemie*, January 1802.

water, and saturated with potash. The molybdate of potash being soluble in a much larger quantity of cold water than the free molybdic acid, this acid was united to potash with a view that a more concentrated solution of it might be applied to the stuff, which, in regard to linen and cotton, is a matter of great importance.

A. One part of this solution was diluted with ten or twelve parts of rain water; and a shred of raw white woollen stuff, and another of white Saxon kerseymere, were boiled in it for half an hour. The two shreds assumed a grayish green colour. Both of them were then cut into small bits, for the purpose of subjecting them to the following experiments;

These bits of cloth were put, 1st, Into a boiling solution of sulphate of zinc very much diluted: 2d, A similar solution of acetite of lead: 3d, Another of sulphate of copper: 4th, Another of tin in the sulphuric and muriatic acids: 5th, Another of sulphate of iron: 6th, Of tin in simple muriatic acid: 7th, Another of tin in acetous acid: 8th, Another of tin in nitro-muriatic acid by muriate of ammonia: 9th, Into one of cobalt in nitric acid, rendered slightly muriatic by muriate of soda: 10th, And into aqueous tincture of gall-nuts prepared cold, which communicated to woollen stuff boiled in it a russet colour.

The different pieces, after being boiled for a quarter of an hour in solution of molybdena, when washed and dried exhibited different shades.

B. A shred of white cotton cloth was immersed, cold, for twelve hours, in a part of the solution of molybdate of potash much diluted; and it was then removed to a diluted solution of tin in a mixture of the sulphuric and muriatic acids. The stuff, which had not changed its colour in the solution of molybdena, assumed a bright blue colour somewhat dirty.

The above two pieces of cloth which were treated with the solutions of tin exhibited this peculiar phænomenon, that on the edge, when cut, they were of a darker and purer blue than externally. Another circumstance, no less remarkable, is, that these colours experienced from the light an effect contrary to that produced on vegetable colours, which lose their colour by exposure to the sun; while that of molybdena acquires a double degree of intensity. The green shades generally passed to blue; but after some time resumed in the shade, or when exposed to the moist atmosphere, their primitive colour.

However satisfactory these results might be, M. Jaeger carried his researches still further, and endeavoured to obtain colours better defined, and brighter; and particularly pure blue

blue and green ſolutions of tin were thoſe which ſeemed moſt likely to accompliſh that end.

C. The ſolution of molybdate of potaſh was mixed, in certain proportions, with pure ſolutions of tin in muriatic acid, diluted in cold rain water. Shreds of raw white woollen ſtuff, moiſtened with boiling water, were boiled for half an hour in this mixture. The liquor was decompoſed, depoſited the tin under the form of a grayiſh powder, and the reſiduum aſſumed an agreeable blue colour, which was communicated alſo to the ſtuff, but with a ſhade leſs pure.

D. Not ſatisfied with this reſult, M. Jaeger tried to prepare the ſtuff, before it was immerſed in the bath of molybdena, with different mordants; ſuch as ſulphate and acetite of alumine, diluted ſulphuric and muriatic acid, acidulous tartrite of potaſh, and others: but the reſult did not anſwer the object he had in view. He then thought it neceſſary to employ other means.

E. A ſolution in exceſs of molybdate of potaſh was then mixed with a ſaturated ſolution of tin; the mixture was boiled for half an hour in a retort, and was afterwards left at reſt for eight or ten days. After this time, the liquid, which at firſt was of a grayiſh blue colour, was found changed into a bright dark blue, and had depoſited a large quantity of gray oxide of tin. The liquid was decanted, and filtered through double paper.

1ſt, This tincture communicated a bright blue colour to a ſhred of muſlin, which had been left in it for a quarter of an hour after it had been diluted in two parts of water.

2d, A ſhred of raw white woollen ſtuff was ſo ſtrongly coloured by this tincture, that after ebullition for half an hour it came out dyed of a pure ſaturated blue colour.

As the tincture did not appear to be exhauſted of colour, there were boiled in it for half an hour, each after the other,

3d, A ſhred of woollen ſtuff.

4th, A ſhred of the ſame kind. The two ſhreds acquired a blue colour, decreaſing in intenſity.

To aſcertain how far the blue colour of the woollen cloth could be fixed, a ſhred of ſtuff was boiled for an hour in one part of blue tincture diluted with half a part of water. Its colour was not darker than that of No. 2.

The dyed ſhred was then cut into two parts, and one of them was boiled for a quarter of an hour in the ſame tincture, to which a little of the ſolution of tin had been added. Its colour this time was more intenſe.

The colour in theſe experiments had diſtributed itſelf perfectly, and had united in ſo intimate a manner with the fibres

of the wool, that the ſtuff had all the appearance of wool dyed with indigo. After this ſucceſs, M. Jaeger endeavoured to unite the colour of molybdena with other vegetable colours, and to tranſport it in that ſtate to ſtuffs. The reſults of this labour were as follow:

F. Different ſhreds of woollen cloth, to which a greater or leſs blue colour had been communicated by tincture of molybdena, were boiled for half an hour in a cold aqueous infuſion of quercitron bark. They acquired different ſhades of green, but which did not poſſeſs all the purity and uniformity which could have been wiſhed. He therefore thought that it would be neceſſary to change a little his proceſs.

G. Different ſhreds of woollen ſtuff were boiled for a longer or ſhorter time in an infuſion of quercitron bark, with a view to communicate to them different ſhades of yellow. The quantity of blue tincture neceſſary for each ſhade of yellow, beginning with the weakeſt, was added to the infuſion, which was in a great part exhauſted. In this manner, ſhades of green, not inferior in beauty to Saxon green, were obtained by an ebullition of half an hour.

H. In other experiments, ſometimes the blue tincture and ſometimes the molybdate of potaſh was tried, either by combination with vegetable colours, or alone, as mordants or modifiers. The reſults in general were very ſatisfactory. Several of the colours thus obtained were ſo fixed and unalterable in the ſun and air, and by ſtrong acids, that no other colour could be compared with them in this reſpect.

M. Jaeger terminates his intereſting labour by announcing a black colour, furniſhed to him by a compoſition of molybdate of potaſh, acetite of alumine, and logwood. This black having been tried, in regard to durability, as compared with common black, by boiling both for a quarter of an hour in diluted ſulphuric acid, that of molybdena was ſcarcely changed, while the other loſt its colour entirely, and paſſed to a burnt yellow.

The author adds alſo, that the blue tincture of molybdena, evaporated in a gentle heat, furniſhed a very fine blue, ſoluble in water, which might be uſed for writing, and even for painting, in the ſame manner as any other colouring juice.

It appears from theſe experiments that molybdena may become a very valuable colouring matter in the art of dyeing.

V. *Re-*

V. *Remarks on the present State of Aërostation. By* Mr. G. J. Wright.

[Concluded from p. 346 of our last Volume.]

THE machine being constructed, it only remains to fill it with inflammable air (hydrogen gas). The usual method of procuring inflammable air is by the solution of iron in sulphuric acid or common oil of vitriol: for this purpose a number * of air-tight casks are disposed in circles of ten or twelve in each circle. The casks composing one circle communicate, by their individual tubes, to one centre cask containing water, whose height must be such as that the orifice of each tin tube should be some inches under the fluid †. The centre casks (or *coolers*, as they are technically termed) are the only ones immediately connected with the balloon, and that by varnished silken tubes proceeding from their summits: there must also be a second orifice in the head of each cask composing the circles; each such orifice being for the purpose of introducing the ingredients, and provided also with an air-tight plug. The iron (of which the turnings from the boring of cannon are reckoned the best) being placed in the casks, the diluted acid ‡ (having been previously well mixed in a separate vessel purposely provided) is to be poured upon it, stopping up the orifice with the plug as soon as the smell of the gas is perceived: the quantity of acid first put into each cask must be half the requisite proportion for the weight of iron therein contained; and this rule must be observed throughout the whole number of casks, so that on the second subsequent addition the aggregate quantity of gas shall be produced §.

The

* This was the method adopted by Mr. Garnerin; but its complexity renders it very exceptionable, as in other experiments two or three casks have been made to answer all that he effects with thirty, and in much less time.

† Without this precaution the inflammable air is liable to carry along with it some of the acid in a vaporous state, which in one instance became gradually condensed in the balloon when arrived to a colder region, deluging the aëronaut with some quarts of this acidulous liquor.

‡ It is necessary to dilute the acid in a separate vessel, not merely on account of the great difference in the respective gravities of the acid and water, which renders stirring necessary, but also on account of the great quantity of heat liberated, which is sufficient to occasion ebullition in some instances, and might derange the apparatus.

§ This is the method adopted by some experimenters; but a more expedient one deserves to supersede it; especially as by nearly the like and undermentioned process Messrs. Baldwin, Sadler, and Lunardi, successfully inflated their machine in two hours.

The

The iron muſt be particularly attended to to inſure ſucceſs; whatever is ruſty is not only not ſerviceable, but actually injurious, by generating hydro-carbonate, a gas ſpecifically

The quantity of hydrogen gas developed during the action of diluted ſulphuric acid upon iron, varies not only according to the ſtrength of the acid, but the quality of the iron employed. Dr. Prieſtley (Experiments and Obſervations on Air, vol. vi) found that annealed caſt iron invariably afforded more inflammable air than iron which had not undergone that proceſs; the difference being nearly 1-8th. Thus iron turnings, as being in ſome degree annealed, gave conſiderably more air than only caſt iron, yet leſs than iron nails perfectly annealed. Mr. Cavendiſh alſo obtained from an ounce of zinc 356 ounce meaſures of inflammable air; from the ſame quantity of iron 412 meaſures; while tin afforded him only half the quantity yielded by iron. Suppoſing then we are about to inflate a balloon of 30 feet diameter, it will require, agreeably to Mr. Cavendiſh's experiments, about two ounces and a half of iron for each cubic foot of inflammable air, or 2200 pounds of iron to be diſſolved in order to completely fill the machine; and to produce this ſolution there will altogether be required an equal weight of concentrated oil of vitriol, and ſix times this weight of water. But completely filling a balloon before its aſcenſion is uſeleſs; becauſe the denſity of the ſurrounding medium, immediately decreaſing, will cauſe an equally premature expanſion of the gas, and require its eſcape even before it attains 1000 yards height: the proportional product, therefore, of 2000 pounds of metal will be as much as may with propriety be applied to a machine of 30 feet diameter.

Having proceeded according to the rules hereafter laid down for aſcertaining the requiſite quantity of materials agreeably to their reſpective purity, provide next two large cylindrical wooden veſſels open at the top, and ſhaped as inverted truncated cones, each veſſel capable of containing about 1000 gallons, ſo that the two may hold in the ſequel the whole quantity of materials. In each of theſe veſſels diſpoſe planes of lattice or baſket-work, at intervals of ſix or eight inches above each other (their diameters correſponding to the diameter of the part of the veſſel each plane is to reſt upon), adding a ſufficient number of them till within a foot of the ſurface at which the diluted acid will ſtand when the whole quantity ſhall have been added. The uſe of theſe planes is for dividing the iron into many portions, ſo as to expoſe as large a ſurface as poſſible to the action of the acid: the weight of iron, ſuppoſing the veſſel to contain ten of theſe planes, will be 100 pounds upon each; which weight will ſuffice for keeping them ſteady, without having recourſe to other methods of fixing them to the veſſel itſelf; while the gas will eaſily find a paſſage for itſelf from the lower through the ſuperior planes by the interſtices in the baſket-work.

Having thus diſpoſed of the iron ſo as that the two veſſels ſhall contain their ſpecific proportion, amounting together to the whole of the required quantity, provide for each veſſel an appropriate head, of ſomewhat leſs diameter than its upper rim, that when fixed therein it may reſt an inch or two below the level of the ſame, in order that a thin ſtratum of water may lie over the whole ſurface, and render the head completely tight. From the centre of the head muſt proceed a cylindrical tube of tin ſix inches in diameter and one foot in height; whence forming a right angle it ſhould proceed about ſix feet, and then deſcend by an obtuſe angle whoſe extremity ſhould terminate in an aſcending nook, converging till its extreme

cally heavier than even common air. It muſt be alſo totally devoid of greaſe, as the ſmalleſt ſtratum of greaſy matter will effectually ſecure the iron from being attacked by the acid. To

treme orifice be diminiſhed to an inch diameter*, and in ſuch a direction as eaſily to be placed under, and ſix or eight inches below, the baſe of the inverted funnel of the reſervoir. Beſides this central tube there muſt be a lateral one of an inch diameter and ſix inches in height, provided with an air-tight wooden ſtopper. Through the head muſt alſo be fixed a glaſs or pewter tube bent to form an inverted ſyphon, the ſhorter leg of which muſt be placed ſo as to be included in the veſſel, while the longer leg (of two feet in length) will remain on the outſide. A third veſſel muſt alſo be provided, as a reſervoir or cooler, capable of holding from 200 to 300 gallons, open at top, yet not more than three feet deep. Acroſs its diameter, and eight or ten inches below its upper rim, ſix two ſtrong wooden bars as ſupports, to which fix an inverted wooden funnel (the baſe of which muſt not be leſs than two feet diameter) whoſe upper part ſhould end in a tube, round which the varniſhed ſilken tube immediately connected with the balloon is to be faſtened. After properly fixing the inverted funnel, provide a ſquare wooden tube, and fix it to the inſide of the reſervoir ſo as to reach within ſix inches of its bottom, while its upper orifice ſhould ſtand at leaſt a foot higher than the ſurface of the water therein. This being done, and the extremities of the large tin tubes being properly placed under the inverted funnel, begin with pouring ſeveral gallons of cream of lime (made by ſlaking quicklime in water, a gallon of fluid to two pounds of lime) into the reſervoir; then gradually fill the ſame with water till within an inch or two of the top. In the next place, pour through the inverted ſyphon of each tub a mixture of one part acid and ſix of water, while an aſſiſtant ſtanding over the ſmall lateral tin tube (now open) replaces the plug in the ſame as ſoon as the ſmell of the hydrogen gas is perceived, indicating that the atmoſpheric air is now all expelled from the tub. And thus muſt the workmen proceed, pouring the diluted acid into the tubs through the ſyphons till ſuch time as the required quantity for each veſſel (*i. e.* 1000 pounds of acid, and 6000 pounds, or 750 gallons, of water) has been added; the column of fluid retained in the ſhorter leg of the ſyphon forming a ſtopper, whereby any eſcape of gas at this aperture is prevented.

A ſeparate aſſiſtant muſt in the mean time attend the pneumatic cooler to renew the water therein, which will be at intervals ſaturated with all the matter it can abſorb from the gas; he muſt therefore occaſionally diſplace this water by pouring freſh quantities down the ſquare wooden tube for the purpoſe, which will cauſe the ſaturated fluid to flow over the top of the veſſel, and in doing the ſame muſt, for every freſh addition of water, add a proportionate quantity of the cream of lime. During the whole of the experiment the water in the cooler muſt be ſtirred with a wooden rod, that the unſaturated lime (continually tending to precipitate itſelf) may be perpetually brought into contact with the gas; while, the more frequent the renewal of the water in the reſervoir, and the larger the proportion of freſh cream of lime, the lighter will the gas be obtained. Alſo, to facili-

* By this contrivance the gas will iſſue in a continued ſtream, which will prevent that great agitation of the water under the funnel which is occaſioned by the gas forcing its way through the water in large quantities at a time, yet at intervals of ſome diſtance, whereby much of it is frequently loſt.

To provide against these two circumstances, the aëronaut ought not to omit subjecting the iron turnings to the action of a strong fire amidst carbonaceous matters, for at least an hour, a day or two before his proposed use of them. The thickness of the iron must be also noticed, as, under the most favourable circumstances, the acid never penetrates it more than half an inch: therefore all the weight of iron that remains over and above a surface of half an inch depth every way, becomes useless; the coat of newly formed oxide of iron effectually guarding the remaining metal from solution: for want of attending to this circumstance, the quantity of metal has frequently proved deficient to the end proposed, to the great disappointment of the experimenter.

Also where the public have to rely on the good faith of the exhibiter, he ought to try the strength of his acid previous to employing it; and this, not by the ordinary methods of specific gravity, nor the quantity of alkali it will saturate *, but by the actual process, in the small way, of what he proposes to perform on the day of ascent: by these means he cannot fail of succeeding.

But the above is not the only method of procuring inflammable air †: the passing of water over red-hot metals is fol-

tate the entrance of the inflammable air into the balloon, the varnished silken tube, proceeding from the inverted funnel, must rather ascend than otherwise in its course to the balloon, which may be easily managed by supporting it along a ladder having a gentle inclination upwards. I apprehend the cost of the larger tubs of 1000 gallons each will be less expensive than to have recourse to twenty or thirty butts for the purpose; which, by dividing the process, causes greater apprehensions for failure with respect to the tightness of so many vessels and tubes; besides the inconvenience of having to procure so great a number of casks for every fresh voyage, when undertaken as a public exhibition in places far distant from each other.

The sulphate of iron, the product of the mutual action of the acid and iron, is a substance much used in the arts under the name of green copperas: the chemist, dyer, calico-printer, ink-maker, refiner, &c. have great demand for this article. It may therefore be either disposed of, or distilled *per se* to regain the acid; while the residuum, by a further calcination, may be converted into that species of oxide known by the name of colcothar, an article much employed for polishing glass and metals, and also as a pigment.

* We are liable to mistakes if we rely on the specific gravity of the acid (usually varying from 1·6 to 1·8), which is augmented by its containing in solution neutral salts, especially sulphate of potash; an adulteration not unfrequently practised. The quantity of alkali required to saturate a given quantity of an acid, can never detect the absolute quantity of the individual acid we are in search of, but only indicate the degree of acidity of the whole, without any regard to the specific radicals.

† Inflammable air is procured in many chemical operations; but it is useless to mention here any other than such as are advantageously applicable to aërostatic purposes.

lowed

lowed by the extrication of a large quantity of hydrogen gas from the decomposition of the water; but the metal is apt to run to a flag resembling finery cinder, preventing its further action upon the water, and that before any considerable proportion is decomposed.

The distillation of pit-coal also affords this gas, but not above one-fourth lighter than atmospheric air. In obtaining it in this way, a number of receivers must be interposed between the retort and the balloon, to condense the volatile, aqueous, and oleaginous products of this distillation *.

If a parachute is required, it should be constructed so as when distended to form but a small segment of a sphere, and not a complete hemisphere; as the weight of this machine is otherwise considerably increased, without gaining much in the opposing surface. The parachute of Mr. Garnerin is particularly defective in a too great extension of its diameter; an unnecessary addition to its weight of a lining of paper both withinside and without; the too near approximation of the basket to the body of the parachute; and especially in the want of a perpendicular cord passing from the car to the centre of the concave of the umbrella, by the absence of which the velocity of the descent is certain to be very rapid before the machine becomes at all distended; whereas, if a cord were thus disposed, the centre of the parachute would be the portion first drawn downwards by the appended weight, and the machine would be almost immediately at its full extension.

Having found, by experiment, the diameter required for insuring safety †, the further the basket or car is from the umbrella, the less fear shall we have of an inversion of the whole from violent oscillations; yet the longer the space between the car and the head of the machine, the longer will be the space run through in each vibration when once begun, yet by so much the more will they be steadier; and this ought to be attended to, as when by the violence of the oscil-

* During the distillation of pit-coal, water and carbonate of ammonia are afforded, together with a pitchy oil resembling tar: these will be condensed in the nearest receivers, while the gaseous product (consisting of a mixture of hydrogen with azotic and carbonic acid gases) will proceed onward; and which if made to pass through lime-water will be rendered more pure: a pound of coal will afford about three cubic feet of inflammable air, and prove the cheapest method of inflation. Dr. Priestley also found that the product of inflammable air, in all operations in the dry way, was always greater in proportion as the fire had been suddenly raised.

† Mr. Baldwin advises the diameter 15 feet; by which means, "the man weighing 140 pounds and the parachute 10 pounds, with a surface of 150 square feet, he would feel no greater shock than if he had fallen from the height of six feet." At the Pantheon, Mr. Garnerin's parachute was announced as being 40 feet in diameter, and weighing above 60 pounds.

lations the car became (in Garnerin's experiment) on a line with the horizontal axis of the machine, (or, in other words, the point of suspension,) the force of gravity, or the gravitating power of the weight in the car, on the umbrella, being at that crisis reduced to nothing, the slightest cause might have carried the body of the machine in a lateral direction, reversing the concavity of the umbrella, and Mr. Garnerin, perhaps, have fallen upon the now convex yet internal portion of the bag, and the whole have descended confusedly together *.

I should

* The umbrella being acted upon in a perpendicular direction from the car, if by any, the most trivial cause, the latter vibrates from the perpendicular it will draw the machine in the same inclined direction; the car also with its cords of suspension, now acting the part of a pendulum, will continue to oscillate to each side till a perfect equilibrium is restored. The space of the arc described in each vibration will depend upon the distance between the car and the parachute conjunctly with the resistance afforded by the latter to the air, whereby on decreasing the resistance (or, which is the same thing, the surface of the umbrella,) the weight in the car will sooner draw the machine into the perpendicular, and the oscillations consequently cease: thus a parachute whose surface is small enough to obviate oscillations in the middle regions (*i. e.* the half of the usual heights surmounted in aërostatic experiments, or about 5000 feet), would be defective for want of surface to moderate the velocity of descent when near the ground, and *vice versa*: if, therefore, we can augment or diminish at pleasure the surface and consequent resistance of the parachute during its descent, we shall have attained the perfection of the machine.

Thus in Mr. Garnerin's experiment the oscillations did not commence till the machine felt the increased resistance of a more dense zone of the atmosphere; and having then no means of diminishing the same, the vibrations began, continued, and increased, till, by arriving in a yet *more* dense region, a greater resistance was opposed to the oscillations of the basket, gradually diminishing the arc of the same to nothing, this also being assisted by a discharge of ballast from the car, by which means the weight of the pendulum and its power to sweep through a dense atmosphere were conjointly diminished; for *the vibration of a pendulum will be in proportion to its length, and also to the density of the medium through which it is to vibrate*; a fact too much overlooked. There is therefore a medium height at which the oscillations will be the greatest; and the distance of this medium from the earth's surface will vary with the different states of the barometer at the earth; or, in other words, as the density at different heights. Thus, when the altitude of an aëronaut descending by a parachute is great, the atmosphere is there too much rarefied to occasion resistance to the umbrella sufficient to allow of an oscillation; but when in a lower zone a vibration has unfortunately begun, the atmosphere is here too dense to allow of that velocity of descent which only could have prevented the commencement of the oscillations, yet not dense enough to afford sufficient resistance to retard the sweep of the basket; while in a yet more dense region, nearer to the surface of the earth, the air affords so much resistance to the swing of the car, as soon effectually to stop the same, especially if the weight therein could now be diminished by a discharge of ballast; a fact evinced in Mr. Garnerin's experiment, when he threw out a quantity of ballast when near the earth to moderate the shock of his descent, which immediately

I ſhould propoſe the parachute to be conſtructed of varniſhed cambric muſlin (or light linen), covered externally with a netting, the meſhes of which ſhould converge ſmaller as they approach the central portion of the machine; obſerving alſo to fix the netting on the ſurface by ſewing it down upon various parts of the ſame. The diameter of the parachute (forming only a ſmall ſegment of a ſphere), when extended, not to exceed twenty feet. The central aperture of the umbrella (to allow the eſcape of the air through, as the machine deſcends), not leſs than three feet in diameter, and provided with a ſhutter moving upon a hinge and opening inwards *; furniſhed alſo with a cord ſliding over a ſingle pulley to ſhut the aperture, and a ſecond cord to open the ſame (each cord reaching to the car), thus ſubjecting the ſhutter to the will of the aëronaut. By this mechaniſm the ſtupefying vibrations of the car may be moderated, if not wholly prevented, by drawing down the ſhutter ſo as to fully expoſe the aperture, whereby the reſiſtance of the parachute to the atmoſphere being leſſened by all this diminution of its oppoſing ſurface, the gravitating power of the appended weight (tending to draw the body of the machine continually in the perpendicular) will have proportionally a greater effect: the deſcent in the interim will be alſo relatively more rapid; but this may be checked in a moment by cloſing the orifice, eſpecially when near the ſurface of the earth †.

A ſtrong cord ſhould proceed perpendicularly from the centre of the car to a point formed by the convergence of a number of cords proceeding from the ſecond ring of wicker-work, the effect of which would be an immediate extenſion of the parachute to its full diameter at the inſtant of deſcent, as before adverted to. Alſo, and laſtly, a third hoop of wicker-work, of ſix or eight feet diameter, fixed in the internal concave of the umbrella, to ſecure againſt any accidental collapſe of the ſides before the machine has become diſtended

diately reſtored the machine to its perpendicular ſituation, but for which he could not account. An attempt to obviate theſe inconveniences is the object of the valve of the parachute mentioned hereafter.

* This aperture, or, more properly, valve, of the parachute, may be conſtructed either of cloſe wicker-work, or varniſhed linen ſtrengthened by a piece of netting externally, and fixed to a ring of wicker-work adapted to cloſe the diameter of the ſecond ring of wicker-work, to which are fixed the pieces of varniſhed linen compoſing the concave umbrella. This latter circle is independent of the third hoop of wicker-work of ſix or eight feet diameter, afterwards mentioned, whoſe uſe is to prevent a collapſe of the ſides of the machine.

† By an enlargement of the diameter of the valve, this diminution of ſurface might be carried to ſuch extent as to inſure a ſafe deſcent by the parachute even in the moſt tempeſtuous weather.

distended by its pressure on the cylinder of air immediately beneath it.

With respect to the probability of directing aërostatic machines *, we may infer it to be possible, although the methods hitherto tried have been inadequate; perhaps because they were not sufficiently powerful; as, to expect to make so large a body as a balloon to vary from the wind by the impulsion of an oar of six or eight feet in length and one or two in breadth (and that by only endeavouring to draw the car out of the perpendicular), is to expect, by means of a boat's oar, to impel a ship of burthen. Oars are doubtless the most likely means to effect this purpose, if they were of dimensions proportionate to the effects they are wished to produce †. The addition of sails, where any variation from the wind is desired, will prove injurious till we have attained a method (perhaps only to be accomplished by oars) of keeping the same point of the balloon continually in a given direction. Yet I doubt not but these also might prove of great service in quick dispatches by water; as, for instance, where it is required to pass a fortress or fleet for the succour of a besieged town, or convey dispatches thereto: a small balloon, of ten or twelve feet diameter, provided with sails to expose a large sur-

* 'Tis a matter of surprise, that the various hints for directing balloons appear to lie dormant with their projectors, who seem indisposed to make any attempts to carry their plans into execution: thus the inventions of professor Danzel (Philosophical Magazine, vol. iv.), also of Martin, and the proposals for performing the same by means of eagles trained for the purpose; or by a reversed parachute to retard the direct progress of the balloon, whereby less power will be necessary to impel it in a lateral direction; all these plans remain obsolete and unpractised from the time of their suggestion.

† According to the present mode of rowing balloons from the car, whatever deviation is made may be compared to the lee-way of a ship at sea; the power being applied so as merely to prevent at a certain instant the car from following the balloon, which will therefore be impelled, during that short interval, in a barely diagonal direction amounting perhaps, in the end of the voyage, to scarcely half a point from the wind. For oars to produce their full effect they should be not less than twenty feet long, and three in width at their extremities; while the rowers should be seated one on each side of the machine in appropriate cars attached to the body of the balloon, and nearly on a line with its equator: this might easily be practised with a balloon capable of carrying four persons and ballast; the greater weight in the car below the machine, containing two travellers with ballast, being sufficient to keep the whole apparatus in a steady position, and that more especially if the same be suspended at a considerable distance beneath the balloon. The oars recommended (being made of only varnished linen stretched over netting fixed to arms of pliable wood) might be easily worked, if a projecting staff of wood were attached to each lateral oar, so as to form at its extremity a fulcrum whereon to rest the oar at eight or ten feet distance from the rower.

face to the wind, being attached by a long rope to a boat, would outstrip the quickest vessel, and might also be made to deviate from the course of the wind; as the water would form a counter-resisting medium, the want of which in air-balloons occasions the difficulty of steering them. A sail-balloon similar to the above might also be advantageously attached to a land-carriage; namely, by increasing the capacity of the balloon so that its power of ascension being nearly equal to the weight of the appended carriage, the latter would be drawn along by the impulsion of the wind against the balloon and sails, while the friction over the ground, by the small overplus weight, may be reasonably expected to afford a resistance sufficient to guide the machine, and allow of a deviation in the carriage of at least eight points from the course of the wind *.

To whatever degree of perfection aërial navigation may attain, the limits to which a traveller might soar will for ever be confined to but a small distance, even supposing that man could exist in any station of the aërial regions however elevated. The density of the atmosphere decreasing in a geometrical proportion, it will be found that, if a sphere of sheet copper †, of half a pound to the square foot, were constructed of equal diameter with our earth (7920 miles), and totally exhausted of its inclosed air, such a globe would attain its equilibrium at 70·047346 miles distance from the surface of the earth; nor would it attain a greater elevation, although its power of ascension at the instant of departure would be equal to 28716916379672707717l2 pounds.

The application of aërostatic machines to the advancement of our knowledge of the various phænomena in meteorology, stands prominent, as the, perhaps, only means of maturing our acquaintance with causes yet known only by their effects. Their use will also be indicated in many urgent cases where other means of conveyance might fall short. At the same time I conclude with remarking, that the hitherto unsuccess-

* A land carriage to be moved by the wind is not a new contrivance: a machine of this kind, rigged in all respects like a sloop, used occasionally to be experimented upon on Barham Downs, near Canterbury: the carriage being of a light construction, and containing two persons, was found capable of running a mile in three minutes and a half, upon level ground and with a fair wind. Whether it could surmount the occasional irregularities of a common road, or deviate in any measure from the wind, I do not now recollect.

† If metallic aërostats were ever to be constructed agreeably to the scheme of the jesuit Francis Lana, means might be found to exhaust them: but to prevent their being crushed together by the pressure of the atmosphere would be more difficult to accomplish!

ful

ful attempts to render aërial navigation of ſervice to mankind, ought to be no argument for cauſing it to be diſcountenanced by men of ſenſe, or prohibited by civil authority; as experiments in any art, however multiplied, if not well adviſed and conducted, cannot be expected to fulfil the erroneous expectations of their projectors.

To aſſiſt the artiſt in conſtructing his aëroſtatic apparatus, it may not be amiſs to ſubjoin the following data:—The diameter is to the circumference of a ſphere as 1 to $3\frac{1}{7}$, or as 1 to 3·1416. The circumference multiplied by the diameter gives the ſurface of the ſphere in ſquare dimenſions, and 1-6th of the ſurface multiplied by the diameter, or the cube of the diameter multiplied by 0·5236, gives the capacity or ſolid contents in cubic meaſure. By the weight of a ſquare foot of the envelope may be found the weight of the whole bag, allowing for the ſeams; and to find the power of aſcenſion, ſubtract the weight of the bag and incloſed air from the weight of an equal bulk of atmoſpheric air *, and the quotient will give the power which the balloon will exert to riſe, which (during its aſcent) will decreaſe till the equilibrium between the two is reſtored; and this point may be nearly aſcertained by recollecting that the denſity of the atmoſphere decreaſes in the geometrical ratio, and is reduced to half an atmoſphere at three miles and a half from the earth's ſurface †. If a balloon with its annexed apparatus weighs therefore, at the inſtant of aſcent, but half an equal bulk of common air, it will riſe to three miles and a half perpendicular height; but, as the denſity of the inflammable air decreaſes alſo in the ratio of the diminiſhing preſſure of the ſurround-

* A cubic foot of water weighs 1000 ounces avoirdupoiſe: and as the denſity of air to water is as 1 to 800, this will be $1\frac{1}{5}$ ounce for every cubic foot of atmoſpheric air: the weight of inflammable air varies according to its purity, ſo as to be even 17 times lighter than common air; but in the groſs way, for aëroſtatic purpoſes we muſt not expect to obtain it more than eight or ten times lighter than atmoſpheric air.

† Agreeably to the annexed table:

At miles			
$3\frac{1}{2}$	- - -	- - 2	
7	- - -	- - 4	
14	- - -	- - 16	
21	- - -	- - 64	
28	- - -	- - 256	
35	the air is	- 1·024	times rarer.
42	- - -	- 4·096	
49	- - -	- 16·384	
56	- - -	- 65·536	
63	- - -	- 262·144	
70	- - -	1·048·576	

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ing air, so if the balloon were originally but a quarter full (by which means room would be left for this subsequent expansion of the gas), the machine would mount proportionally higher than the three miles and a half, by as much more as the relative density of the gas is become less. Thus, if, as is now allowed, we reckon the volume of all elastic fluids to be inversely as the pressure, and that the balloon was at first but a quarter full (yet of half its weight of power of ascension), it would not stop till arrived at seven miles height, and the machine would be at its full distension, the density being here lessened four times what it was at the moment of ascension. But if the machine (whose power of ascension is equal to half its whole weight) was at first half full, the gas would be expanded to twice its volume at three miles and a half; the balloon would then be full, and all further rise would be prevented by the air escaping at the neck by all the subsequent rarefaction; and if this was prevented by tying the neck, the machine would burst. But we are prevented from knowing to what precise height a balloon will rise, from the yet unaccounted-for circumstance of the temperature of the contained air always much exceeding that of the surrounding medium: and as there is not that coincidence in the expansions of different gases by temperature, as is the case with respect to barometrical pressure; so, till we are better acquainted with the cause of this diversity of temperature, and the precise expansion of the gas by the varying degrees of the same, we must rest satisfied with a rough calculation in supposing the temperature of the internal and external air to correspond *.

The annexed table (extracted from Mr. Cavallo's treatise) shows the proportion between the surfaces and capacities of spheres of various diameters, remembering that the specific

* From the mode of inflating aërostatic machines, and the dissolving power of all elastic fluids, the contained gas will always hold in solution more or less water in an extremely divided state. In the elevated and cold regions of the atmosphere this vaporous fluid will be condensed in small drops in the inner concavity of the balloon; but the before-combined yet now free caloric (to which the fluid owed its vaporous state, and which, in every condensation of a fluid, or change of state of its aggregation from aëriform elasticity to a fluid or solid state, is given out,) will be prevented from escaping to the external air by the non-conducting quality of the envelope: it will therefore serve to augment the temperature of the hydrogen gas; while in a warmer zone (or when a large and white cloud is so situated as to become a mirror to the balloon, strongly reflecting the rays of the sun upon the same,) the contrary effects will ensue—the water will reassume the vaporous state, and the temperature of the gas be proportionally reduced, as far as relates to its contained water.

quantity

quantity of the number in the first column, whether reckoned as inches, feet, or yards, must be the same in each lateral column; as square inches, feet, or yards, in surface—and cubical inches, feet, or yards, in capacity *.

Diam.	Surface.	Capacity.	Diam.	Surface.	Capacity.
1	3·141	0·523	26	2124	9203
1½	7·068	1·767	27	2290	10306
2	12·567	4·188	28	2463	11494
2½	19·635	8·181	29	2642	12770
3	28·274	14·137	30	2827	14137
4	50·265	33·51	31	3019	15598
5	78·54	65·45	32	3217	17157
6	113·097	113·097	33	3421	18817
7	153·938	179·594	34	3632	20580
8	201·062	268·083	35	3848	22449
9	254·469	381·704	36	4072	24429
10	314·159	523·6	37	4301	26522
11	380·1	696·9	38	4536	28731
12	452·5	904·8	39	4778	31060
13	530·9	1150·3	40	5026	33510
14	615·8	1436·7	45	6362	47713
15	706·9	1767·1	50	7854	65450
16	804·2	2145	55	9503	87114
17	907·9	2572	60	11310	113098
18	1017·9	3054	65	13273	143794
19	1134·1	3591	70	15394	179595
20	1256·6	4189	75	17671	220804
21	1385·4	4849	80	20106	268083
22	1520·5	5575	85	22698	321556
23	1661·9	6371	90	25447	381704
24	1809·6	7238	95	28353	448922
25	1963·5	8181	100	31416	523599

* I have omitted to particularize the method of cutting the pieces composing a balloon, which will vary according to the width of the stuff; as the smallest ingenuity will enable any one to describe a pattern, only recollecting the length in circumference of the machine required, together with its proposed shape. Also the heights of the barometer are omitted (as requiring corrections for temperature too nice for any but philosophical amateurs, who may, with propriety, be supposed to be already masters of this essential branch of the science) for the present purpose—only recollecting that, without regard to the difference of temperature, an elevation of 16 fathoms, or 96 feet, is usually allowed for the fall of every tenth of an inch of the mercury.

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So long as the vibration of pendulums is performed in a medium of varying denfity, we muft not look for an accurate time-piece for afcertaining the longitude, &c.; unlefs a felf-correcting mercurial pendulum could be contrived, adapted to counteract the fmalleft variations effected by the ambient air. The errors of a time-piece are but half corrected by the fabrication of pendulums adapted to obviate the expanfion of metals by increafe of temperature, if the works themfelves ftill remain conftructed of fuch expanfible materials. A correct time-piece, therefore, will be that of which not only the works and pendulum are conftructed of the leaft expanfible materials, but the pendulum itfelf fhall vibrate in a medium of unalterable denfity; a defideratum only to be obtained by caufing the vibrations to be performed *in vacuo*, or by a felf-correcting pendulum, as above alluded to. I know of no fubftance fo well adapted to compofe the works of fuch a machine as ivory, or the horn of the narwhal or fea unicorn (nearly entirely compofed of enamel, and ufed in the fabrication of artificial teeth), efpecially if we had a means of increafing their hardnefs fo as to vie with the metals (a fubject on which I propofe to make fome experiments): but for the pendulum itfelf, the common gridiron pendulum is allowed to be the moft accurate in ufe, provided its vibrations were not obftructed by unequal refiftance from the air: but for a mercurial pendulum to move in open fpace, glafs will be indicated as the leaft expanfible and moft proper fubftance for this purpofe. I add, that the moft perfect time-piece hitherto conftructed, has been fo only in as far as the works have been moft exactly accurate, and the expanfion of the pendulum been counteracted (as in the gridiron pendulum) by oppofing expanfion to expanfion. The exact concordance of fuch a machine, on its return to the firft place of obfervation, will have depended on the nature of the voyage performed in the interim. As, if fuch voyage has been performed acrofs the equator and back (as to the Eaft Indies), the aggregate number of anomalies in the pendulum in the voyage out, will in the return be nearly balanced by the number of anomalies in the voyage home, fo that the whole difference fhall at laft, perhaps, not amount to 100″. But if (fome weeks after the failing of the veffel) we had it in our power to know at a certain inftant the precife moment indicated by an equally accurate chronometer left at the place of departure, we fhould find a greater variation between the two, owing to the difference in the denfities of the media in which the pendulum at home

home and that on board the ſhip have in the interim vibrated. I ſay then,

1. That the concordance (although exact) of two chronometers, after a voyage on the part of one of them, is no proof of their accuracy.

2. That this concordance will depend on the nature of the voyage that has been performed in the interim. And,

3. That we muſt not expect an exact inſtrument till the expanſions by heat, and the varying denſity of the atmoſphere, are counteracted in the ſame machine.

For although the difference of an inch barometrical preſſure may not cauſe an obſtruction in the arc of vibration equal to the two millionth part of the whole, yet this ſmall difference (which, perhaps, may have prevented its hitherto due obſervance,) will, in the ſpace of ſome months, amount to ſomething conſiderable, eſpecially as a variation of not only one, but two or even three inches increaſe or diminution of preſſure will frequently enſue in leſs than 24 hours.

Kennington,
January 17, 1803.

VI. *A Sketch of the Geography of Cochin China; ſome Particulars relative to the Manners, Cuſtoms, and Hiſtory of the Inhabitants; and a few Conſiderations on the Importance of forming an Eſtabliſhment in that Country* *.

COCHIN CHINA, called by the natives Anam, extends from about the 20th degree of north latitude to Pulo Condore, which lies in 8° 40′. It is bounded by the kingdom of Tonquin on the north, from which it is ſeparated by the river Sungen; by the kingdom of Laos, and by a range of mountains, which divides it from Cambodia, on the weſt; and by that part of the Eaſtern Ocean generally called the China Sea, on the ſouth and eaſt.

The kingdom is divided into twelve provinces, all lying upon the ſea-coaſt, and ſucceeding each other from north to ſouth in the following order:

Ding-oie, *Cong-bing*, *Ding-cat*, *Hue* (or the Court), in the poſſeſſion of the Tonquineſe. *Cham*, *Cong-nai*, *Quinion*, in the poſſeſſion of Ignaack. *Phu-yen*, *Bing-khang*, *Nabtong*, Bing-thoam (or *Champa*), dubious whether ſubdued by Ignaack, or ſtill in the poſſeſſion of the king. *Donai*, in the poſſeſſion of the king.

* From the *Aſiatic Annual Regiſter for* 1801.

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The breadth of the country bears no proportion to its length. Few of the provinces extend further than a degree from eaſt to weſt, ſome leſs than twenty miles: Donai, which is properly a province of Cambodia, is much larger.

The whole country is interſected by rivers, which, although not large enough to admit of veſſels of great burthen, yet are exceedingly well calculated for promoting inland commerce.

The climate is healthy, the violent heat of the ſummer months being tempered by regular breezes from the ſea. September, October, and November, are the ſeaſon of the rains; the low lands are then ſuddenly overflowed by immenſe torrents of water which fall from the mountains. The inundations happen generally once a fortnight, and laſt for three or four days. In December, January, and February, there are frequently rains brought by cold northerly winds, which diſtinguiſh this country with a winter different from any other in the eaſt. The inundations have the ſame effect here as the overflowings of the Nile in Egypt, and render the country one of the moſt fruitful in the world. In many parts the land produces three crops of grain in the year. All the fruits of India are found here in the greateſt perfection, with many of thoſe of China.

No country in the eaſt produces richer or a greater variety of articles proper for carrying on an advantageous commerce; cinnamon, pepper, cardemoms, ſilk, cotton, ſugar, Agula wood, Japan wood, ivory, &c. Gold is taken almoſt pure from the mines; and, before the troubles, great quantities were brought from the hills in duſt, and bartered by the rude inhabitants of them for rice, cloths, and iron. It was from them alſo the Agula and Calambae woods were procured, with quantities of wax, honey, and ivory.

The animals of Cochin China are bullocks, goats, ſwine, buffaloes, elephants, camels, and horſes. In the woods are found the wild boar, tiger, and rhinoceros, with plenty of deer; the poultry is excellent, and the fiſh caught on the coaſt abundant and delicious. The fleſh of the elephant is accounted a great dainty by the Cochin Chineſe. The breeding of bullocks is little attended to; their fleſh is not eſteemed as food, and they are made no uſe of in tilling the land, which is performed by buffaloes. They are totally unacquainted with the art of milking their cattle.

The aborigines of Cochin China are called Moys, and are the people which inhabit the chain of mountains which ſeparate it from Cambodia. To theſe ſtrong-holds they were

 driven

driven when the present poſſeſſors invaded the country. They are a ſavage race of people, very black, and reſemble in their features the Caffrees.

It was about the year 1280 of the Chriſtian æra that the firſt Tartar prince became poſſeſſed of the throne of China. This revolution afforded an opportunity to the weſtern provinces to throw off their dependence; and they were formed into a kingdom, under a prince whoſe deſcendant now reigns in Tonquin, and is called Knaw-Whang. About the beginning of the fifteenth century a large body of people from theſe provinces, being diſaffected to the government, joined under a leader of abilities; they ſoon became maſters of the coaſt of Cochin China as far as Cape Aurilla, which lies in latitude 12° 30′ north. The Moys, the original inhabitants, retired to the hills bordering their country to the weſtward; where they have ever ſince remained. The emigrants, under their conductor, founded the kingdom of Cochin China. The continual wars they were engaged in with the Tonquineſe, induced them to build a wall on the ſouthern extremity of the province of Ding-noi, to prevent their irruptions. Every communication by ſea was ſtrictly forbidden. In the year 1764 the country of Cochin China was in a flouriſhing condition, and governed by a prince of abilities: ſoon after his ſon ſucceeded to the throne, and anarchy and confuſion enſued.

The Cochin Chineſe bear evident marks of their being derived from the ſame ſtock as the Chineſe. They reſemble them in their features, and moſt of their manners and cuſtoms. Their religion is the ſame: their oral language, though different, ſeems formed upon the ſame principles; and they uſe the ſame characters in writing. They are a courteous, affable, inoffenſive race, rather inclined to indolence. The ladies are by far the moſt active ſex; they uſually do all the buſineſs, while their lazy lords ſit upon their haunches, ſmoking, chewing beetle, or ſipping tea. Contrary to the cuſtom of China, the ladies are not ſhut up; and, if unmarried, a temporary connection with ſtrangers who arrive in the country is deemed no diſhonour. Merchants often employ them as their factors and brokers, and, 'tis ſaid, the firmeſt reliance may be placed on their fidelity.

The habit of the men and women is cut after the ſame faſhion. It is a looſe robe, buttoning with a ſmall robe round the neck, and folding over the breaſt like a banyan gown, with large long ſleeves which cover the hands. People of rank, and eſpecially the ladies, wear ſeveral of theſe gowns

one over the other; the undermoſt one reaches to the ground, the ſucceeding ones are each ſhorter than the other, ſo that the diſplay of the different colours makes a gaudy appearance as they walk along.

Such are the few particulars relative to Cochin China. It now remains to ſhow how a connection with Cochin China may prove beneficial to this country. The drain of ſpecie from the company's ſettlements in India is become a matter of ſuch ſerious import, that any plan which may be offered to remedy ſo growing an evil, I have no doubt, will be deemed worthy of obſervation. I am ſanguine in my expectations, that a ſettlement in Cochin China would conduce to that deſirable end, as well as be productive of many other advantages.

Our two little veſſels brought from Cochin China to the amount of 60,000 rupees in gold and ſilver bullion. The Rumbold, the year before, alſo brought bullion to a conſiderable amount, on account of ſales of Bengal and Madras cloths, opium, iron, copper, lead, hardware, and glaſs.

The ſituation of Cochin China is excellently well adapted to commerce. Its vicinity to China, Tonquin, Japan, Cambodia, Siam, the Malay coaſt, the Philippines, Borneo, the Moluccas, &c. renders the intercourſe with all theſe countries ſhort and eaſy. The commodious harbours formed on the coaſt, particularly that of Turon, afford a ſafe retreat for ſhips of any burthen during the moſt tempeſtuous ſeaſons of the year.

The nations of Europe, having hitherto found it impoſſible to provide cargoes ſufficiently valuable to barter for the commodities of China, are obliged to make up the deficiency by ſending thither immenſe quantities of bullion; by which means it has, for a number of years paſt, drained the eaſtern and weſtern worlds of their ſpecie. The number of junks annually reſorting to Cochin China, plainly proves how much the productions of it are in demand amongſt the Chineſe. Theſe productions, had we a ſettlement and a confirmed influence in the country, might with eaſe be brought to centre with us, purchaſed with the ſtaples of India and of Europe. Turon would become the emporium for them, where our ſhips bound to Canton, from whence it is only five days ſail, might call and receive them. It would prove a ſaving of ſo much ſpecie to Great Britain or India as the value of the commodities amounted to in China. In a few years, there is every reaſon to believe a very conſiderable inveſtment might be provided.

Our trade to China has ever been burthened with enor-

mous imposts and exactions: these, under various pretences, are annually increasing, and in process of time may become insupportable. It is an opinion, latterly grown current, that the Chinese are desirous of totally excluding all Europeans from their country. May we not hazard a conjecture, that the vexations they oblige them to suffer are the premeditated schemes of this politic people to effect it? Were such an event to happen, the want of a settlement to the eastward would be severely felt; the Chinese would export their own commodities, and Java or the Philippines, as the nearest ports, would become the marts for them. As there is no reason to suppose that our inability to procure them from the first land would hinder their consumption, we must buy them either from the Dutch or from the Spaniards. A settlement in Cochin China will give us a superior advantage to either, both as its situation is nearer, and the Chinese are more accustomed to resort thither: at all events there is reason to suppose it will enable us to procure the commodities of China at a much more reasonable rate than now purchased by our factors at Canton, and certainly on less humiliating terms to the nation at large. Colonies of Chinese have from time to time emigrated from the parent country; and fixed their abode in different parts of Cochin China. These have their correspondence in every sea-port of the empire. Through their means, teas, china ware, and the various other articles, the objects of our commerce with China, might be imported in junks to our own settlements, equally good in quality, and cheaper, as the Chinese are exempted from the exorbitant duties levied on foreigners. Some of the best workmen might be encouraged to settle in Cochin China, and, under direction, manufactories carried to as great a degree of perfection as in China itself.

The intercourse between Japan and Cochin China might be renewed, and we might participate in a trade for many years monopolized by the Dutch. An advantageous trade might be carried on with the Philippine islands, and Madras and Bengal goods introduced amongst them, by means of the junks, for the consumption of Spanish America. The Siamese and Cambodians would bring the produce of their respective countries, and barter or sell them for such articles as they wanted from Cochin China. Amongst them it is probable a sale might be found for quantities of Bengal cloths. The lower class of people in Cochin China are, for the most part, clothed in cangas, a coarse cotton cloth brought from China; but the preference, which I had an opportunity of observing, they gave to Bengal cloths, on account of their being

being wider and cheaper, would ſoon induce them to adopt the uſe of them. The demand for opium, already in ſome meaſure become a neceſſary of life to the Chineſe, would increaſe in proportion to the facility of procuring it. The importation of it, no longer confined to Canton, but carried by the junks to every ſea-port in the country, would ſpread the demand for this drug to the remoteſt parts of the empire.

But what inſpires the moſt flattering hopes from an eſtabliſhment in this country is its rich gold mines, celebrated for ages as producing the richeſt ore, ſo pure, that the ſimple action of fire is ſaid to be ſufficient to refine it. I omitted no opportunity of making inquiries reſpecting this valuable article, and was told that mines were formed in different parts of the northern provinces, and particularly in Hué, where the ore lay ſo near the ſurface of the earth that it was dug up with little labour. Under the direction of a ſkilful metallurgiſt, what might not be expected from ſuch a ſource!

Great as the commercial advantages are, the political ones reſulting from a ſettlement in Cochin China would be ſcarce inferior. Turon Bay would not only afford a ſecure retreat to our Indiamen in caſe of loſing their paſſage to China, but from thence we might alſo intercept the fleets of any hoſtile power, either going to or returning from that country. We ſhould become formidable neighbours to the Dutch and to the Spaniards, and, in the event of a war with either of them, attack, with advantage, their moſt valuable ſettlements.

Should the company be induced to form a ſettlement in Cochin China, it may be effected on principles ſtrictly juſt, and at a ſmall expenſe. Several of the royal family, beſides the mandarins who were in Bengal, with many officers of the late government, urged me to uſe my endeavours with the government of Bengal to induce it to afford them aſſiſtance, promiſing a powerful ſupport whenever we ſhould heartily join in their cauſe. To reſtore their lawful ſovereign to the throne, would be now a meaſure ſo popular, that the ſincerity of their offers cannot be doubted. To relieve an unhappy people, groaning under the weight of the moſt cruel oppreſſion, would be an act worthy of the Britiſh nation. Fifty European infantry, half that number of artillery, and two hundred ſepoys, would be ſufficient for this and every other purpoſe. The natives of Cochin China are infinitely below the inhabitants of Hinduſtan in military knowledge; I have, however, no doubt that a body of them, well diſciplined and regularly paid, would prove as faithful to us, and contribute as much to the ſecurity of any poſſeſſions which we might acquire to the eaſtward, as the ſepoys do to our territories in

 India.

India. In caſe of any diſtant expeditions, they would be found ſuperior, being entirely free from all religious prejudices, and having no objection to the ſea.

While Cochin China remains in its preſent diſtracted ſtate, a favourable opening is preſented to the firſt European nation that may attempt to obtain a footing in the country. Should the company, therefore, entertain a deſign of forming an eſtabliſhment in Cochin China, no time ſhould be loſt in carrying it into execution.

VII. *Report preſented to the Claſs of the Exact Sciences of the Academy of Turin, 15th Auguſt 1802, in regard to the Galvanic Experiments made by* C. VASSALI-EANDI, GIULIO, *and* ROSSI, *on the 10th and 14th of the ſame Month, on the Head and Trunk of three Men a ſhort Time after their Decapitation. By* C. GIULIO.

THE Firſt Conſul, in a letter to Chaptal, in which he announced to that miniſter the two prizes he had founded to encourage philoſophers to make new reſearches in regard to Galvaniſm, ſays, "Galvaniſm, in my opinion, will lead to great diſcoveries." This obſervation was juſt and profound: great diſcoveries have already been made; Galvani and Volta have immortalized their names, and ſeveral celebrated philoſophers and phyſiologiſts have rendered themſelves illuſtrious in this branch of ſcience, ſo abundant in aſtoniſhing phænomena: yet it is only in its infancy, and there can be no doubt that many important diſcoveries ſtill remain to be made.

Vaſſali, Roſſi, and myſelf, have for ſeveral years been employed in reſearches on this ſubject. While the firſt examined the Galvanic fluid in every point of view, for the purpoſe of illuſtrating its nature by means of a great number of ingenious experiments, performed with that care and exactneſs which are peculiar to him, Roſſi and myſelf attempted to explain the action of the Galvanic fluid on the different organs of the animal economy.

Sometimes I was obliged to interrupt my reſearches by unfortunate circumſtances, and at others by my adminiſtrative functions: but I have now reſumed them; and though ſucceſs has not yet crowned my efforts by any brilliant diſcovery, we truſt, and with confidence, that we ſhall be able to add ſome valuable facts to the hiſtory of the animal economy; to rectify errors; to confirm facts already received; and to

to extend the domain of an inexhauſtible agent fertile in wonders.

Volta had announced that the involuntary organs, ſuch as the heart, the ſtomach, the inteſtines, the bladder and veſſels, are inſenſible to the Galvanic action *: but we have fully refuted this great phyſiological error. Unfortunately, however, the Latin memoir containing the deciſive experiments which we made on cold-blooded and warm-blooded animals in 1792, preſented to the Academy ſoon after, and which, according to Sue, in his Hiſtory of Galvaniſm †, "are curious, and contain very intereſting obſervations," did not appear till 1801, when it was printed in the laſt volume of the Tranſactions of the Academy.

In that interval Grapengieſſer found, as we had done, that Galvaniſm, by means of zinc and ſilver ‡, has an influence on the periſtaltic motion. Humboldt aſcertained the Galvanic action on the hearts of frogs, lizards, toads, and fiſhes. Smuch obſerved the excitability of the heart by the Galvanic fluid; and Fowler changed the pulſations of the heart without the immediate application to it of armatures, and only by adapting them in warm-blooded animals to the recurrent nerve by means of the ſympathetic §.

It is chiefly in regard to the experiments of theſe learned Germans that the hiſtorian of Galvaniſm ſtates ||, that the involuntary vermicular motion of the inteſtines, according to the acknowledgment of all phyſiologiſts, obeys metallic irritation; whence it follows, ſays he, that the Italian philoſophers have advanced an error when they ſaid that Galvaniſm exerciſes no action but on the muſcles, which depend on the will. As an accurate and impartial hiſtorian, how can Sue accuſe the Italian philoſophers indiſcriminately of ſuch an error, ſince he had our memoir before him when employed on the ſecond volume of his Hiſtory of Galvaniſm, and ſince he gave a ſhort account of my experiments in his firſt volume? Nay, I gave an account of my experiments in a ſmall work publiſhed in Italian in 1792. But as Italian works are not much read in France, and were leſs ſo at that period, I ſhould not have reproached C. Sue with this act of injuſtice,

* Mezzini, Volta, Valli, Klein, Pfaff, Berhends, have denied that the heart could be moved by the Galvanic fluid. *Hiſt. du Galvaniſme*, part i. p. 145. Bichat could obtain no contractions either in the heart of man or that of the dog. See *Récherches Phyſiologiques ſur la Vie et la Mort.*

† Towards the end of the firſt part.

‡ See *Hiſtoire du Galvaniſme*, vol. ii. p. 81.

§ Ibid. vol. ii. p. 84. || Vol. ii. p. 83.

and his incorrectness in regard to the Italian philosophers, had not my Latin memoir been known to him, as it had appeared in the Transactions of the Academy.

Though we made a great many experiments before we attempted to combat a philosopher so justly celebrated as Volta, and to establish the influence of Galvanism on the involuntary organs; and though Grapengiesser, Humboldt, Smuch, Fowler, &c. ascertained this influence in certain cold-blooded and even warm-blooded animals; an object of so much importance to physiology required to be extended and confirmed, especially in man, by new experiments. We have been the more sensible of the necessity of establishing this fact in an incontestable manner, either in regard to the involuntary organs in general, or more particularly the heart, as the celebrated Aldini, professor of Bologna, in an Italian work replete with new facts and valuable experiments made on the bodies of decapitated criminals, has been obliged to acknowledge that he was not able to obtain any contraction in that organ by means of the electro-motor of Volta, which is so powerful.

We shall give an account, in particular memoirs, of the experiments we have already made, and of those which we propose to execute. In regard to the stomach, the large and the small intestines, and the bladder, we shall say only, in a general manner, that by armature of the different nervous branches we obtained contractions analogous to those described in regard to animals. The Galvanic action on the heart and arteries is the object of the present paper, as it is of the utmost importance to physiology, and deserves, under every point of view, to excite our attention and occupy our reflections.

Our experiments on the different parts of the head and trunk of the decapitated criminals were begun, on the 10th of August, in a hall of the large hospital of St. John, and resumed and continued yesterday in the anatomical theatre of the university, before a great number of spectators.

We tried the influence of Galvanism on the heart in three different ways:

1st, In arming the spinal marrow by means of a cylinder of lead introduced into the canal of the cervical vertebræ, and then conveying one extremity of a silver arc over the surface of the heart, and the other to the arming of the spinal marrow. The heart of the first individual subjected to our experiments immediately exhibited very visible and very strong contractions. These experiments, as seen, were made without

out any intervention of the pile, and without any armature applied to the heart. It is very remarkable, that when the former is touched first, and then the arming and spinal marrow, the contractions of the heart which follow are more instantaneous, and stronger, than when the arming of the spinal marrow is first touched, and then the heart. In a memoir on Galvanism, read in the last public sitting of the academy, I gave an account of a great number of experiments, made especially on frogs, which exhibited a similar phænomenon. In these animals I observed, a great number of times, that when the arming of the crural nerves was touched first, and then the muscles of the thigh, there were no contractions, or the contractions were exceedingly weak; and, on the other hand, that when the muscles of the thighs were first touched, and then the arming of the crural nerves, as long as the least vitality remained in the organs the contractions of the muscles were constant and violent. In the memoir already mentioned I have endeavoured to account for this phænomenon, to which I shall recur when, by a great number of trials, we shall have ascertained that it is as general in men as I found it in frogs and other cold-blooded animals.

The second manner in which we tried the influence of Galvanism on the heart was by arming the nervi vagi and the large sympathetic. The object of these experiments will be readily comprehended by anatomists acquainted with the details of neurology. In these, as well as in the first and other experiments where we armed the cardiac nerves themselves, we obtained contractions in the heart. In this, as in the former case, the contractions obtained when the heart was first touched, and then the arming of the nerves, were much stronger than when the arming of the nerves was touched first, and then the heart. In this method we even observed that the Galvanic experiments sometimes failed.

The third kind of experiments on the heart were performed by means of the pile. The pile we employed on the 10th of August, for the experiments on the first decapitated criminal, was composed of fifty plates of silver and as many of zinc, with pasteboard moistened with a strong solution of muriate of soda. The silver was mixed with a tenth part of copper. This is the proportion which we found most favourable to the intensity of the signs of Galvanism:

	Metre.
The diameter of the silver plates was -	0·036
Their thickness - - -	0·0015

The dimensions of the pieces of pasteboard were the same.

The

		Metre.
The diameter of the zinc plates was	-	0·042
Their thickneſs	- - -	0·0035

The pile employed for the experiments on the 15th of Auguſt was compoſed of fifty plates of pure ſilver, and twice that number of plates of zinc and pieces of paſteboard; the latter moiſtened in a ſolution of muriate of ſoda.

		Metre.
The diameter of the ſilver plates was	-	0·038
Their thickneſs	- - -	0·001

The dimenſions of the pieces of paſteboard were the ſame.

		Metre.
The diameter of the zinc plates was	-	0·04
Their thickneſs	- - -	0·001

By making the negative extremity of the pile to communicate, by means of reſpective conductors, with the ſpinal marrow, or merely with the muſcles of the back or breaſt, laid bare, and the poſitive extremity immediately with the heart, inſtantaneous and violent contractions were obtained; and the contractions were produced alſo when the heart was made to communicate with the negative extremity of the pile, and the ſpinal marrow with the poſitive extremity.

We ſhall obſerve, in regard to contractions of the heart, that of all its parts the apex is the moſt ſuſceptible of motion, and the moſt ſenſible to the Galvanic influence: we muſt obſerve alſo, that the contractions produced by communication with the pile were not only ſtrong, but that they continued a long time even after all the communication was removed.

A very remarkable circumſtance is, that the heart, which of all the muſcles retains longeſt, in general, its contractility in regard to mechanical ſtimulants, is the firſt to become inſenſible to the Galvanic influence. The muſcles of the arms, and thoſe of the back and breaſt, continue to be excitable by Galvaniſm for whole hours; and the heart had loſt its excitability about forty minutes after death.

The experiments made yeſterday in the anatomical theatre exhibited nearly the ſame reſults in regard to the heart as thoſe already mentioned. The great arteries, ſuch as the aorta and ſome of its branches, being injected with water raiſed nearly to the ſame temperament as that of the blood in the living individual, when ſubjected to the Galvanic action exhibited contractions. But it is probable that they will appear ſtronger when trials of this kind ſhall be made on bodies endowed with a higher degree of vitality than thoſe of yeſterday, and when the interval between the period of decapitation

decapitation and that of the experiments ſhall be leſs. With this view, indeed, we have provided a hall much nearer to the place of execution; for the reſults which we obtained in the man decapitated on the 10th of Auguſt, in which caſe the experiments were begun five minutes after the decapitation, were all comparatively more ſtriking, and ſtronger, than thoſe obtained in the experiments of yeſterday, which were begun more than twenty minutes after decapitation, and which were performed, as appears, on bodies endowed with a much weaker degree of vitality.

In the experiments made on the arteries, we armed the nervous plexus, which envelop the trunks of the cœliac and meſenteric arteries, ſeveral branches of which are even interwoven around the aorta: a communication was eſtabliſhed between the poſitive or negative extremity of the pile and the aortic artery itſelf. It was by theſe means that we obtained riſible contractions.

If the effects of Galvaniſm on arterial contractions are conſtant, as I preſume, all thoſe diſcuſſions which have been agitated ſo long, and with ſo much violence, in regard to the irritability of the arteries, which does not manifeſt itſelf by the action of different mechanical and chemical ſtimulants, will at length be terminated in a poſitive and irrefragable manner; all doubts will at length be removed; and we ſhall be indebted to the Galvanic fluid, which is the moſt energetic of all agents applied to the animal fibre, for having fixed the opinions of phyſiologiſts on a point of ſo much importance to the animal economy.

Whence comes it that Aldini, even with the help of the moſt powerful electro-motors, was not able to obtain contractions in the heart of man, which we ſo evidently obtained by the ſame means which always withſtood his efforts? How happens it that we obtained contractions by means much weaker?

The firſt experiments of Aldini on the human heart were begun an hour and a half after death *. The trunk had been expoſed a long time to the open air, the temperature of which was no more than + 2. It is probable that the cold, and the long interval between the period of death and that of the experiment, had already annihilated the irritability of the heart †. In the fifty-third experiment, the heart of another executed

* Saggio di Sperienze ſul Galvaniſmo di Gioani Aldini; Bolonia 1802, p. 14, eſp. 28.

† If the celebrated Bichat failed in his experiments on the human heart, as well as Aldini, it was, perhaps, owing to the ſame cauſes. The temperature

executed criminal constantly remained motionless and insensible to the Galvanic current. But in this experiment, before trying the heart, a considerable time was employed in making trials on the voluntary organs, the sensibility of which to Galvanism had already been acknowledged. But the very reverse of this method ought to be followed; for I will here repeat, that excitability, by means of the Galvanic fluid, is extinguished in the heart a long time before it becomes extinct in the voluntary muscles. This is so certain, that while no part of the heart, tried externally and internally, presented any sign of contractions, the diaphragm, and the muscles of the upper and lower extremities, gave very strong ones.

In our experiments which were begun five minutes after death, the heart ceased to be sensible to the Galvanic agent about the fortieth minute; and this was the case in the temperature of + 25; while the voluntary muscles retained their Galvanic excitability for whole hours. In other experiments made by Aldini, the contractility of the voluntary muscles existed three hours, and even five hours, after death.

In the oxen subjected to Galvanic experiments by Aldini, the excitability of the heart must have been extinguished sooner, since the action of the Galvanic fluid of the pile produced no contractions, though applied immediately after death.

If contractions were observed in the voluntary muscles under the same circumstances, it was because these muscles, which lose much sooner than the heart their excitability in regard to mechanical stimulants, retain it much longer than that organ in regard to the Galvanic agent. What then is the cause of this diversity, which seems contrary to every analogy, and which, however, is proved by facts? It is still involved in much obscurity: but it is not yet time to tear the dark veil which conceals it; we are not yet enlightened by a sufficient number of facts; and the few scattered data which we have been able to collect, cannot yet be connected in a manner capable of encouraging us to attempt to rend the veil at present.

We shall not here speak of the astonishment with which the spectators were struck when they saw the contractions of the

perature was cold, and the interval between the time of execution and that of the experiment too long. "I was authorized," says Bichat, "in the winter of the year 7, to make various trials on the bodies of unfortunate persons who had been guillotined. I had them at my disposal from thirty to forty minutes after execution. It was always impossible for me to produce the least motion by arming either the spinal marrow and the heart, or the latter organ and the nerves which it receives from the ganglions by the sympathetic, or from the brain by the par vagum.

the frontal muſcles, thoſe of the eye-lids, the face, the lower jaw, and the tongue; when they beheld the convulſions of the muſcles of the arms, the breaſt, and of the back, which raiſed the trunk ſome inches from the table; the contractions of the pectoral muſcles, and the exterior and interior intercoſtal muſcles, which diminiſhed the intervals between all the ribs, and made them approach each other with violence, raiſing the inferior ones towards the ſuperior, and the latter towards the firſt rib and the clavicle; the contractions of the arms, which, when the uncovered biceps muſcle was touched, as well as its tendon, were ſo ſpeedy and violent, that complete flexion of the fore-arm on the arm took place, and that the hand raiſed weights of ſome pounds fifty minutes after decapitation. Similar experiments may be ſeen in the work of Aldini: our object in this report was merely to ſpeak of the Galvanic influence on the heart and arteries of man, which had not yet been obſerved.

Theſe new and important reſults, which we obtained in regard to the heart and arteries of man, will be confirmed by other trials. We ſhall repeat our experiments as ſoon as an opportunity occurs, and we ſhall take care to give you an early account of the moſt remarkable obſervations we ſhall make.

VIII. *A Review of ſome Experiments which have been ſuppoſed to diſprove the Materiality of Heat.* By William Henry *.

THE following remarks on the ſubject of heat were written ſoon after the publication of Count Rumford's Inquiry concerning the Source of the Heat evolved by Friction; and of the intereſting Eſſays of Mr. Davy, which appeared in Dr. Beddoes's Weſt Country Contributions. They were tranſmitted to Dr. Beddoes, for publication, about the cloſe of the year 1799; but circumſtances, with which I am unacquainted, have, I believe, induced the doctor to decline the continuation of his periodical work. Theſe circumſtances I deem it neceſſary to ſtate; becauſe, had the eſſay been written nearer the period of its publication, it would probably have aſſumed a very different form. At preſent, I have not leiſure to review the ſubject, or to attempt any material alteration; and ſtill leſs to examine whether I have been anticipated by any of the authors whoſe eſſays have been publiſhed during the two laſt years.

* From the *Mancheſter Society's Tranſactions*, vol. v. part 2.

A Review of some Experiments which have been supposed to disprove the Materiality of Heat.

It has long been a question among philosophers, whether the sensation of heat, and the class of phænomena arising from the same cause, be produced by a peculiar kind of matter, or by motion of the particles of bodies in general. The former of these opinions, though far from being universally admitted, is now most generally received; and the peculiar body, to which the phænomena of heat are referred, has been denominated by M. Lavoisier caloric. Against the doctrine of the French school, some forcible arguments have lately been advanced by Count Rumford and by Mr. Davy; both of whom have adopted that theory respecting heat, which assigns as its cause a motion among the particles of bodies.

The method of reasoning employed by Mr. Davy in proving the immateriality of the cause of heat, is the *reductio ad absurdum*, i. e. the oppugned theory is assumed as true, together with its applications; and facts are adduced directly contradictory of the assumed principles: I shall take the liberty of offering a statement of the argument, rather different from that of Mr. Davy, though, I trust, without misrepresentation, or any material omission.

Let heat be considered as matter; and let it be granted, that the temperature of bodies depends on the presence of uncombined caloric. Now, if the temperature of a body be increased, the free caloric, occasioning that elevation, must proceed from one of two sources: either, 1stly, It may be communicated by surrounding substances; or, 2dly, It may proceed from an internal source, *i. e.* from a disengagement of what before existed in the body, latent or combined. But the temperature of bodies is uniformly increased by friction and percussion, and necessarily in one of the foregoing modes.

I. Mr. Davy found, by experiment, that a thin metallic plate was heated, by friction in the exhausted receiver of an air-pump, even when the apparatus was insulated, from bodies capable of supplying caloric, by being placed on ice. This experiment he considers as demonstrating, that the evolved caloric could not be communicated by surrounding bodies.

To the inference deduced from this experiment it may be objected, that the mode of insulation was by no means perfect. Admitting the vacuum, produced by the air-pump, to have been complete, still the supply of caloric could not thus

thus be entirely cut off, ſince it has been ſhown by Count Rumford that caloric paſſes even through a torricellian vacuum. If, therefore, friction produce in bodies ſome change, which enables them to attract caloric from ſurrounding ſubſtances, this attraction may be equally efficient in an exhauſted receiver as in one containing an atmoſphere of mean denſity. It would be an intereſting ſubject of experiment to determine the influence of atmoſpheres of various denſities as conductors of caloric; for, ſince effects are proportionate to their cauſes, and it is aſcertained that common air conducts caloric (better than it is conveyed through a vacuum) as 1000 is to 702, it may be expected that the ratio will hold in all intermediate degrees.

In Count Rumford's maſterly experiment, the metal ſubmitted to friction was encompaſſed by water, and air was carefully excluded from the ſurfaces in motion: yet the water became hot, and was kept boiling a conſiderable time. In this caſe, the only obvious ſource of caloric, from without, was through the borer employed in producing the friction; if it be true, as the Count has obſerved, that the water could not, at the ſame inſtant, be in the act of giving out and receiving heat. The ſame objection to the communication of heat, from an external ſource, exiſts alſo in thus explaining Mr. Davy's experiment: but I cannot admit that the argument is demonſtrative in proving the evolved caloric not to be derived from external ſubſtances; for no abſurdity is implied in ſuppoſing that a body may be receiving caloric in one ſtate, and giving it out in another. We have an example of the ſimultaneous admiſſion and extrication of a ſubtile fluid, the materiality of which is admitted by Mr. Davy, in an excited electric, which, at the very ſame inſtant, receives the electric fluid from without, and transfers it to the neighbouring conductors. In an ignited body, alſo, the two proceſſes of abſorption and irradiation of light are, perhaps, taking place at the ſame moment.

II. Another cauſe of the increaſe of temperature in bodies, is the liberation of their combined caloric; and if this be a ſource of temperature, the abſolute quantity of caloric in a body muſt be diminiſhed by friction. That no ſuch diminution really takes place, we have the evidence of two experiments,—the one of Mr. Davy, the other of Count Rumford. Mr. Davy, by rubbing together two pieces of ice, converted them into water. Now water, *ex hypotheſi*, contains more caloric than the ice from which it was formed; and, on the ſame hypotheſis, the abſolute quantity of caloric in ice is diminiſhed by friction and liquefaction; which is abſurd.

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Count Rumford also ascertained that the specific heat of iron was not diminished when converted by a borer into turnings, and consequently when it had been the source of much temperature. In explanation of these facts we may be allowed to assume the communication of caloric from surrounding bodies, till this communication has been demonstrated to be impossible. But even were the impossibility established, it would yet remain to be proved, that the evolved caloric does not proceed from an internal source; and this can only be done by an accurate comparison of the quantity of caloric in bodies before and after friction. Now, in instituting this comparison, it is implied that we possess means of determining the absolute quantity of caloric in bodies, and that we can compare quantities of caloric with as much certainty as we can obtain from an appreciation by weight or by measure. Such perfection, however, does not, I apprehend, belong to the present state of our knowledge respecting heat; for I have always been distrustful of that part of the doctrine which assigns the ratio of heat latent in bodies. The grounds of this distrust I shall state pretty fully; for, if it can be proved that we have no accurate conceptions of quantity, as appertaining to heat, all arguments against its materiality, derived from supposed determinations of its quantity, must be inconclusive.

The only clear conceptions which the mind has of quantity, are derived either from a comparison of the magnitude or of the gravity of bodies. In the instance of caloric, both these modes of mensuration fail us. We cannot estimate the bulk of a substance which eludes our grasp and our vision; nor have we yet succeeded in comparing its gravity with that of the grosser kinds of matter, which it surpasses in tenuity beyond all comparison. Our notions of the quantity of caloric are derived, not from such simple judgments, but from complicated processes of reasoning, in the steps of which, errors fatal to the whole may perhaps sometimes appear.

Whatever be the nature of caloric, whether it be a body *sui generis*, or a quality of other bodies, its effects are peculiar and appropriate; and, like all other effects, bear a proportion to the energy of their cause. Expansion, for example, it is proved by experiment, keeps pace with the actual increments of heat; and on this principle is founded the thermometer, the great agent in the acquirement of all our ideas respecting heat, both absolute and relative. The competency of this instrument, however, to afford information of the quantity of caloric, is limited by the following circumstances:

1st, The mercury of the thermometer indicates only the quantity of heat which it has itself acquired, and by no means

that contained in ſurrounding bodies. 2dly, The ſcale of expanſion is wholly arbitrary, commencing far from the abſolute privation of heat, and falling far ſhort of its maximum. 3dly, The caloric latent in bodies, or chemically combined with them, has no effect on the thermometer. 4thly, The experiments of Dr. Crawford, though ſufficient to ſhow that the expanſion of the mercury of the thermometer bears a ratio to the actual increments of heat in any temperature between the boiling and freezing points of water, by no means prove that this proportion holds univerſally.

Equal weights of heterogeneous bodies, it is preſumed, contain unequal quantities of caloric; and the ratio of theſe quantities is approximated in the following manner:

Equal weights of the ſame body, at different temperatures, give, on admixture, the arithmetical mean; but equal weights of different bodies, at different temperatures, afford a temperature which varies conſiderably from the mean. Thus a pound of water at 100°, and a pound at 200°, give the temperature of 150°; but a pound of water at 200°, and a pound of mercury at 100°, afford, not the mean, but a temperature conſiderably higher. Hence it follows, that a pound of mercury has not the power of fixing and retaining ſo much caloric as a pound of water; and the fixation of more heat by the water than by the mercury, is aſcribed to the ſuperior energy of a power inherent in both, and termed capacity for caloric.

From an extenſive ſeries of experiments Dr. Crawford infers, that the capacities of bodies are permanent ſo long as they retain their form. Thus, the capacity of water has to that of mercury the ratio of 28 to 1, at any temperature between 32° and 212°. The difference of capacities of bodies, it is inferred, therefore, would continue the ſame down to the abſolute privation of temperature. Imagine, then, two bodies at this point of privation: they may ſtill contain unequal quantities of combined caloric; for, when chemically combined, caloric does not produce temperature. On Dr. Crawford's hypotheſis theſe comparative quantities of combined caloric in the two bodies may be learned by obſerving the ratio of temperature produced by the addition to each of ſimilar quantities of heat. This ſuppoſition, however, is manifeſtly gratuitous; and the contrary might be maintained with equal or greater probability; for it may be ſuppoſed that at this aſſumed negation of temperature one body renders latent more caloric than another, becauſe it actually contains leſs, as certain dry ſalts attract more water from the atmoſphere than others

containing much water of cryſtallization. The commonly employed mode of aſcertaining the ſpecific caloric of bodies is founded, therefore, on an aſſumption which is deficient in the character of a datum, and which itſelf requires proof.

If theſe objections be valid, they will apply alſo to ſhow the fallacy of the theorem for finding the abſolute zero of bodies. By this term ſome philoſophers appear to underſtand the point of abſolute privation of caloric, both free and combined. I apprehend, however, that in ſtrict propriety it can only be uſed to ſignify the negation of *uncombined* caloric, or, as Dr. Crawford expreſſes himſelf, the point of abſolute cold. As applied, however, to water, it is evident that the whole quantity of heat is underſtood. In aſcertaining the zero, ſay theſe calculators, the capacity of ice to that of water is as 9 to 10. It is plain, therefore, that when water freezes it muſt give out 1-10th of its whole heat; and this tenth part is found to anſwer to 146° of Fahr. Conſequently its whole heat is ten times 146, or 1460°; and hence the natural zero is 1460 — 32, or 1428°. Now of this eſtimate it is a datum, that the capacities of ice and water have preciſely the above ratio. But if the general formula for aſcertaining the ſpecific caloric of bodies be founded on erroneous principles, it cannot ſerve as the ground-work of any ſolid concluſions.

The materiality of caloric may, I apprehend, be maintained, without admitting that we have made any ſteps towards determining its quantity in bodies; and the arguments of Count Rumford and Mr. Davy are not demonſtrative, becauſe they aſſume that this part of the doctrine of caloric cannot be relinquiſhed without abandoning it *in toto*. I may be permitted, therefore, to ſtate my reaſons for believing caloric to be matter; which would have been unneceſſary had the contrary been proved with all the force of mathematical demonſtration.

Avoiding all metaphyſical reaſoning on the nature of matter, and aſſuming the generally received definition as ſufficiently characterizing it, I ſhall examine how far this general character of matter applies to the individual—caloric. Caloric occupies ſpace, or is extended, becauſe it enlarges the dimenſions of other bodies; and, for the ſame reaſon, it is impenetrable, ſince, if it could exiſt at the ſame time in the ſame place with other bodies, their volume would never be enlarged by the addition of heat. Of form or figure, as only a mode of extenſion, it is unneceſſary to prove that caloric is poſſeſſed; and, indeed, there is perhaps only one general quality of matter that will not be allowed it, viz. attraction. That caloric is influenced by the attraction of gravitation, or

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by cohesive attraction, has never yet been proved: yet the various experiments of Buffon, Whitehurst, Fordyce, Pictet, &c. cannot be alleged as proofs that it is actually devoid of this property; since they only decide, that the small quantities which can be artificially collected, are not to be set in the balance against the grosser kinds of matter. One kind of attraction, *that* which has lately been termed chemical affinity, may, I think, after a full survey of phænomena, be fairly predicated of caloric; and if its possession of this quality be rendered probable, we shall thence derive a powerful argument in favour of its materiality.

That chemical affinity has a considerable share in producing the phænomena of heat, appears probable from the following considerations:

1. All the characters distinguishing caloric when separate, cease to be apparent when it has contributed to a change of form in other bodies; and the properties of the substances so changed are also materially altered. Now this is the only unequivocal mark of chemical union that we can apply in any instance; and chemical union implies the existence and efficiency of chemical affinity.

2. The relation of caloric to different substances appears to observe that peculiar law, which, in other instances, is termed elective affinity. If a compound of two or more principles, a metallic oxide for instance, be exposed in a high temperature, the caloric forms a permanent union with the one, but not with the other. In certain instances, caloric is evolved, when two substances, attracting each other more powerfully than they attract caloric, produce, on admixture, an elevation of temperature. In other instances, caloric is absorbed when it is attracted by the new compound, more strongly than by the separate components. Such facts warrant the deduction, that caloric is subject to the laws of chemical affinity. But the precise order of its affinities remains to be decided by future experiments.

3. Caloric seems also, on some occasions, to bear a part in the operation of double elective affinities. In this way it produces decompositions, which, by single affinity, it is incapable of effecting. Thus a most intense fire does not expel entirely the carbonic acid from alkalies: but, when the affinity of an acid for an alkali concurs with that of carbonic acid for caloric, a decomposition ensues. Again: water may be submitted to the highest temperature without imparting a gaseous form to the hydrogen which it contains; but the conspiring affinity of a metal for oxygen occasions the production of hydrogenous gas. On this principle many

chemical facts are resolved into the law of *double affinity*, which are at present explained by that of single elective attraction.

4. Caloric acts sometimes as an intermedium in combining bodies which, without its aid, are not susceptible of combination. Thus carbon and oxygen do not evince any tendency to combination at the ordinary temperature of the atmosphere; but caloric brings them into union, and constitutes itself part of the resulting compound. This, and a variety of other instances, have a striking resemblance to what is called *intermediate affinity*.

In the theory of Dr. Crawford, no influence is allowed to chemical affinity over the phænomena of heat; and, indeed, *that* philosopher expresses a decided opinion that elementary heat is not capable of uniting chemically with bodies. Hence it appears, that the difference between the terms *affinity* and *capacity* is not merely a verbal one, but that they are actually expressive of different powers or causes; and the question, therefore, which of these terms shall be adopted in the description of facts, is one involving the determination of causes.

The term capacity for heat is employed, by Dr. Crawford and others, to denote, in the abstract, that power by which different kinds of matter acquire different quantities of caloric. But in the various applications that are made of this theory, a more precise meaning is often affixed to it; and the term is applied in much the same sense which it has in common language. When thus understood, a difference of capacity necessarily implies a difference in the extent of the spaces between the minute particles of bodies; and that these differences occasion the varieties observed in the acquirement of heat by different bodies. On this theory there is no active principle or power inherent in bodies, and more active in some than in others,—no tendency in the matter of heat to attach itself, in preference, to any one substance. The assigned cause of the phænomena of heat is not, I apprehend, adequate to produce the effects ascribed to it.

On the theory of capacities, a change of form is, in certain instances, antecedent to the absorption of caloric. Thus, when ether is converted into gas, on removing the pressure of the atmosphere, according to this hypothesis, the capacity of the ether is increased by its volatilization; and the change of form is prior to, and the cause of, the absorption of caloric. The order of events, then, in the volatilization of ether is first an alteration of form; next, a change of capacity; and, lastly, an absorption of caloric. On this hypothesis, ether may exist in the state of gas without containing a

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greater absolute quantity of caloric than in a liquid form. But such an interpretation of phænomena is directly contradictory to an established principle, admitted even by those who prefer the doctrine of capacities, viz. that all bodies, during their conversion from a fluid to a vaporous state, absorb caloric. It is at variance also with observed facts: for, if a thermometer be immersed in a portion of ether, confined under the receiver of an air-pump, the temperature of the ether will be found to sink gradually during the exhaustion of the air; and the evaporation becomes proportionally slower, till, at last, it is scarcely perceptible. We may therefore infer, that, at a certain point of diminished temperature, the volatilization of ether would entirely cease, if the supply of caloric from surrounding bodies could be completely intercepted. But, on the theory of capacities, the evaporation should proceed as rapidly at the close as at the commencement of the process; or, in other words, evaporation should be wholly independent of temperature, which every one knows is contrary to fact.

It may be considered, therefore, as extremely probable, that the tendency of ether to assume a gaseous form depends on its chemical affinity for caloric. But, it may be asked, how is this affinity counteracted by an increased pressure, and augmented by a diminished one?

A circumstance absolutely essential to the formation of gases is, that free space shall be allowed for their expansion. Mechanical pressure acts as a counteracting force to this expansion, and either prevents it completely or partially, according to the degree of its application. But from this fact no argument can be drawn against the existence of chemical affinity as an attribute of caloric. Two opposite forces in physics may be so balanced, that neither shall produce its appropriate effect. Thus, a body impelled in contrary directions may remain at rest; yet the operation of the opposing forces, in this case, cannot be denied. Even in chemistry, we have unequivocal examples in which the action of the affinities is suppressed by more powerful causes. Thus, bodies that have a strong chemical affinity are kept perfectly distinct even when placed in contact by the affinity of aggregation. The only inference, then, that can fairly be deduced from the effects of pressure in preventing the formation of gases, is, that it is a power sometimes superior in energy to that of chemical affinity.

Since, therefore, caloric is characterized by all the properties, except gravity, that enter into the definition of matter, we may venture to consider it as a distinct and peculiar body.

 No.

Nor is its deficiency of gravity fufficient to exclude it from the clafs of material fubftances. Such nicety of arrangement might, with equal propriety, lead us to deny the materiality of light, the gravity of which has never yet been proved; for, befides the experiments of Mr. Michell, which failed in afcertaining this property of light, we have feveral chemical facts tending to the fame conclufion. Thus Mr. Cavendifh, after firing a mixture of hydrogenous and oxygenous gafes in a clofe veffel, a procefs during which much light is always emitted, found not the fmalleft diminution of weight.

To have completed this defence of the material nature of heat, it would have been proper to have pointed out the circumftances in which the phænomena of heat differ from the known and acknowledged phænomena of motion. At prefent, however, I have not leifure to purfue the fubject at much length; and though feveral points of difagreement would doubtlefs be found, I fhall mention only one of the moft marked and decifive.

Motion is an attribute of matter, independently of which it cannot poffibly fubfift. If, therefore, the phænomena of heat can be fhown to take place where matter is not prefent, we fhall derive from the fact a conclufive argument againft that theory of heat which affigns motion as its caufe. Now, in the experiment of Count Rumford, before alluded to, heat paffed through a torricellian vacuum, in which, it need hardly be obferved, nothing could be prefent to tranfport or propagate motion. This experiment, in my opinion, decidedly proves that heat can fubfift independently of other matter, and confequently of motion; in other words, *that heat is a diftinct and peculiar body* *.

* The argument at p. 49, which is the bafis of my objections to the commonly employed mode of afcertaining fpecific caloric, I fear, is not fo fully and clearly ftated as the abftrufe nature of the fubject requires.

Affuming two bodies, A and B, to be at the point of privation of temperature, or to poffefs no free caloric whatfoever, the quantity of combined caloric in each, according to Dr. Crawford's theory, is *directly* proportional to the quantities of heat neceffary to produce equal elevations of temperature in the two bodies. Thus, if to attain a given temperature, A require caloric as 20, and B only as 10, the combined caloric of A, before this addition, is inferred to have borne to that of B the ratio of 2 to 1. But it might, with equal or perhaps greater probability, have been affumed that the combined caloric of A and B is *inverfely* proportional to the quantities of heat required to produce a given temperature; that A, for example, to attain a certain temperature, has abforbed more caloric than B, becaufe in A lefs caloric exifted previoufly in a ftate of chemical union.

IX. *Report made to the Philosophical and Mathematical Class of the French National Institute in the Sitting of August* 18, *entitled A Tour to Upper Egypt above the Cataracts of Sienne, with Observations on the different Kinds of Senna used in Commerce. By* C. DESSESSARTZ *and* VENTENAT.

C. NECTOUX, one of the scientific men whom the government had made choice of to form part of the commission of the sciences and arts which accompanied general Bonaparte to Egypt, being appointed to observe the agricultural system of the country, by examining its plants as well as other objects of natural history, embraced that opportunity of acquiring some more certain information in regard to the senna which Alexandria supplies to all Europe, and particularly to France.

The magazines of Alexandria and Cairo were the first sources which he minutely inspected. All the bales of senna were opened to him, and he found not only the two kinds already known, but also a third plant added to them, the leaves of which have a great resemblance to those of the real senna. But fearing, and with reason, that the information he should thus obtain would be as imperfect and incomplete as that before published, he resolved to examine the different species in the places where they are cultivated, and in the different states of growth, that the description he intended to give might be as full and accurate as possible.

With this view he visited and examined, with great care, the environs of Alexandria, Rosetta, Damietta, and Cairo; but without success: he did not find a single plant of senna in the whole space inclosed in the Delta. The senna, therefore, is called the senna of Alexandria merely because that city is the general entrepôt from which it is transported to Europe; and senna *de la palthe,* because such entrepôts are called *palthe,* which signifies a farm: the managers are called *palthiers.*

By the information obtained from the different palthiers, among whom he mentions, with gratitude, C. Rosetty, and from the inhabitants of the country, he learned that senna plants were to be found in the valleys of Sienne. He therefore proceeded thither, and had the satisfaction of meeting with some, and of collecting several loaded with flowers and fruit. Encouraged by this success, nothing was able to restrain the ardour of his curiosity; neither the violence of the heat, nor the difficulty of a long journey through parched

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and rugged mountains, nor the dread of the ferocious Arabs, among whom it was impoſſible to travel without imminent danger. He diſpatched ſome of the natives, who brought him ſpecimens of the different plants they met with. But being ſupported by the civil and military authorities, whom the example and wiſhes of the commander in chief had inſpired with the ſame zeal for the promotion of every thing that could contribute to the progreſs of the ſciences, he penetrated to every place where he had been told or ſuſpected that he ſhould find ſenna.

It was in the deſert in the environs of Baſſa-Tine, two leagues from Cairo, that he collected the firſt plants of ſenna belledy: on the left bank of the Nile, oppoſite to Hermantis or Fallach, he met with a greater abundance, as well as in the neighbourhood of Darao.

The good ſenna and arguel, a kind of cynanchum, of the beſt quality, and in the higheſt ſtate of pefrection, grow in great abundance in the valley of Baſabras, or of Nubia, from which it is brought by the caravans to Darao and Sienne; and it is thence tranſmitted, at leaſt in the greater part, to Alexandria. In the mountains, three days journey above Sienne, the guebelly, the ſenna of the Thebaid, and the arguel, are found; the laſt mentioned in pretty large quantity in a valley which runs to the eaſt of Sienne turning towards Egypt.

In theſe places, whether valleys, hills, or mountains, the good ſenna guebelly and the arguel receive no more culture than the belledy, which is conſidered as wild. The plants grow ſpontaneouſly in groups. There are two crops, the abundance of which depends on the duration of the rains, which take place periodically every year. The firſt, which is the moſt plentiful, takes place at the end of the rains, which begin at the ſummer ſolſtice and terminate towards the middle of September. The ſecond takes place about the middle of March.

The preparation conſiſts merely in cutting the plants, and expoſing them to the ſun on the rocks till they are brought to a ſtate of perfect deſiccation. The two kinds are mixed ſometimes in Nubia, but the belledy is never found in that part of the country. It is only in the entrepôts of Sienne and Cairo that it is added. The accounts given of the quantities collected and depoſited in the magazines, and of thoſe ſold, juſtify the fear of great and dangerous adulteration by the addition of foreign plants. For, according to the acknowledgment of the palthier, the product of the two crops varies from 700 quintals to 1100 or more, a third of which is

 arguel,

arguel, and the ſale is 1400 or 1500 quintals. Among that received by our merchants are leaves of the *colutea* and box.

Unfortunately ſuch inſtances of fraud, which are too common in commerce, are attended with more ſerious conſequences than that practiſed in regard to various kinds of drugs. They occaſion much trouble to our druggiſts, who are obliged to pick the ſenna with the utmoſt care.

The antient botaniſts diſtinguiſhed theſe two kinds of ſenna, and the terms they employed for that purpoſe, *foliis acutis* and *foliis obtuſis*, expreſſed with ſufficient clearneſs and preciſion the differences they exhibit. Linnæus, however, thought it neceſſary to unite them, and to conſider them as varieties. C. Lamarck notices in his dictionary, under the head *caſſia*, the error into which this celebrated botaniſt has fallen. He diſtinguiſhes two kinds of ſenna which grow in Egypt. One, the leaves of which are acute, is announced under the name given to it by Forſkal, *caſſia lanceolata*; and the other, the leaves of which are obtuſe, under that of *caſſia ſenna*. The obſervations preſented to the claſs on theſe two plants by C. Deliſle, and afterwards by C. Nectoux, eſtabliſh alſo ſeveral other differences. The *caſſia ſenna* is diſtinguiſhed from the *caſſia lanceolata*, not only by the obtuſe leaves, but alſo by the ſtipulæ, which are longer and ſhaped like a lance, and by its bent pod having on the middle of each face projecting ridges.

The deſcription given by C. Nectoux, when compared with that of C. Deliſle, gives a reſemblance of characters, which facilitates a diſtinct knowledge of the claſſification of theſe plants, which have been long valued on account of their medical qualities. It is under this point of view we ſhall conſider them.

In the year 6, C. Bouillon-Lagrange publiſhed a chemical analyſis of the ſenna of the palthe of Alexandria, which is uſed in commerce. We conceived that, by delivering to him the three kinds of plants, an ample proviſion of which had been entruſted to us by C. Nectoux, we ſhould be able to preſent to the claſs at the ſame time a knowledge of the principles contained in the ſenna and arguel, compared with that already obtained in regard to the ſenna of commerce. Our wiſh has been fully gratified by the zeal and ability of C. Lagrange. It will not appear aſtoniſhing to you, that the two analyſes of the years 6 and 10 preſent the ſame reſults, with the exception of ſuch ſmall differences that they can have no influence on the opinion which phyſicians ought to form of the action of the two kinds of ſenna, ſince the ſenna of

of commerce is nothing elſe than a compound of the three kinds, which C. Nectoux collected and preſerved ſeparately.

The two old kinds were ſubjected ſeparately to examination, and their products without much impropriety may be ranked in the ſame claſs. It remained therefore to ſubject to the ſame reſearches the plant arguel, called ſenna of Mecca, placed in the claſs of the cynanchum by C. Nectoux, who has given an ample deſcription of it. The following is the reſult of the chemical experiments made with it by Bouillon-Lagrange.

"It appeared to me," ſays he, "that this ſubſtance contained a ſmaller quantity of extractive matter. Infuſion, either cold or hot, decoction, and evaporation of the liquors gave only a ſmall quantity of extract, and this extract in regard to its principles was always analogous to the extracts of the two old kinds of ſenna. The ſame effects therefore, but in a weaker degree, are to be expected from it. But this difference is of great importance in the practice of medicine, and ought to be attended to, as well as the form under which the remedy is adminiſtered.

The reſearches made at the ſame time by our colleague Vauquelin and Bouillon-Lagrange on a conſtituent part of ſenna, which has been conſidered as reſinous, and conſequently as the moſt active, will eſtabliſh more certain ideas reſpecting this kind of purgative.

C. Nectoux ſent with the leaves, ſmall twigs and pods of the ſenna guebelly, and the flowers which he gathered from that plant. Theſe flowers, according to the reſearches of Bouillon-Lagrange, give the ſame reſults, only that they do not communicate ſo much colour to the liquor in which they are infuſed or boiled. They have not ſo ſaline and bitter a taſte as the leaves; their odour alſo is different, and every thing announces that they contain leſs of the purgative principles.

This memoir appears to us particularly important in an economical point of view, as the author propoſes to tranſplant the Egyptian and Nubian ſenna to St. Domingo, where it may be cultivated in diſtricts abandoned by the planters. C. Nectoux aſſures us that theſe plants would ſucceed equally well in the Iſles of France and Reunion, and alſo in Cayenne.

X. *Bio-*

X. *Biographical Account of* MATTHEW BOULTON, *Esq.**

IF genius and indefatigable induſtry, directed by the pureſt patriotiſm, have any claim to the notice of our readers, an authentic account of this gentleman cannot but be highly acceptable to them. When we contemplate the enlarged extent of his views, the wide and rapid circulation of his improvements and diſcoveries in the moſt important branches of art, and the numerous and honourable connections which he has formed in every part of the civilized world, we ſhall be obliged to admit that few men poſſeſs greater claims to the attention and gratitude of their country.

Matthew Boulton, ſon of Matthew Boulton, by Chriſtian, daughter of Mr. Peers, of Cheſter, was born at Birmingham the 14th of September 1728. He received the chief part of his education at a private grammar-ſchool kept by the Rev. Mr. Anſted, who officiated at St. John's Chapel, Deritend.

So early, we believe, as the year 1745, Mr. Boulton, having loſt his father, who left him in flouriſhing circumſtances, diſtinguiſhed himſelf by the invention of a new and moſt ingenious method of inlaying ſteel. Buckles, watch-chains, and a great variety of other articles wrought at his manufactory, were exported in large quantities to France, where they were eagerly purchaſed by the Engliſh, who affected to have no taſte for the productions of their own country.

The confinement of a populous town was but ill ſuited to ſuch an eſtabliſhment as ſoon became neceſſary for Mr. Boulton's further experiments. Accordingly, in the year 1762, he purchaſed thoſe extenſive tracts of common, at that time a barren heath, with only a ſmall houſe and mill, on which the Soho manufactory now ſtands. He laid the foundation of his preſent extenſive works at the expenſe of nine thouſand pounds. To this ſpot his liberal patronage ſoon attracted great numbers of ingenious men from all parts; and by their aid he ſo eminently ſucceeded in imitating the or moulu, that the moſt ſplendid apartments in this and in many foreign countries received their ornaments from Soho. Here, too, the works of the greateſt maſters in oil colours were mechanically taken off, with ſuch eaſe and exactneſs that the original could ſcarcely be diſtinguiſhed from the copy. This mode of copying was invented, we believe, by Mr. Egging-

* From Public Characters of 1800-1801.

ton,

ton, whose performances in stained glass have since introduced his name to the public.

The utmost power of the water-mill, which Mr. Boulton had hitherto employed, fell infinitely short, even with the aid of horses, of that immense force which was soon found necessary to the completion of his designs. Recourse was therefore had, about the year 1767, to that *chef-d'œuvre* of human ingenuity, the steam engine. In speaking of that wonderful machine, we shall adopt the animated language of a late excellent Review:—The steam engine, approaching to the nature of a perpetuum mobile, or rather an *animal*, is incapable of lassitude or sensation, produces coals, works metals, moves machines, and is certainly the noblest *drudge* that was ever employed by the hand of art. Thus we "put a hook in the nose of the Leviathan:" thus we "play with him as a child, and take him for a servant for ever *;" thus "we subdue nature, and derive aid and comfort from the elements of earthquakes †."

The first engine that Mr. Boulton constructed was on M. Savary's plan, of which the reader will find one of the most satisfactory accounts in Professor Bradley's "New Improvements of Planting and Gardening‡," &c. But the machine was yet, as it were, in its infancy, and by no means answered Mr. Boulton's expectations. In the year 1769 Mr. James Watt, of Glasgow, obtained a patent for such a prodigious improvement of it, that Mr. Boulton immediately sought his acquaintance, and induced him to settle at Soho. At this place, the facility of its application to a variety of concerns, wherein great force was requisite, soon manifested its superior utility and vast advantages to the public: Parliament, therefore, in 1775, cheerfully granted a prolongation of Mr. Watt's patent for twenty-five years. A partnership now commenced between Messrs. Boulton and Watt; and a manufactory of steam-engines, on their improved plan, was established at Soho, which still supplies the chief mines and manufactories throughout the kingdom.

Aided by such talents, and commanding such unlimited mechanical powers, Mr. Boulton's views soon expanded, and Soho began to exhibit symptoms of the extraordinary advantages it had acquired. The art of coining had long stood in need of simplification and arrangement; and to this art Mr. Boulton no sooner turned his attention, than, about the year 1788, he erected a coining-mill on an improved plan,

* Job, xli. 2—4. † Analytical Review, Feb. 1797, p. 220.
‡ Seventh edit. p. 315.

and

and ſtruck a gold medal of the full weight of a guinea, and of the ſame form as that of his new copper coinage lately put into circulation. The ſuperior advantages of that form are obvious. The impreſſion is far leſs liable to friction; and by means of a ſteel gauge of equal diameter, money coined on that principle may be examined by meaſure as well as by weight, the rim being exactly circular. Moreover, the intrinſic is ſo nearly equal to the current value of every piece, that, without a ſteam-engine and adequate apparatus, every attempt to counterfeit the Soho coinage muſt be made with loſs. The fabrication of baſe money ſeems likely, by theſe means, to be ſpeedily checked, and, it is to be hoped, entirely defeated. The reaſon why Mr. Boulton has not yet been employed by government in the coinage of gold and ſilver, we have not been able to learn.

The mill at Soho works eight machines, *each of which receives, ſtamps, and delivers out, by the aid of only a little boy, from ſeventy to ninety pieces of copper in one minute.* Either of them is ſtopped without the ſmalleſt interruption to the motion of the others. In adjoining apartments all the preparatory proceſſes are carried on with equal facility and diſpatch; ſuch as rolling the copper into ſheets, dividing them into blanks, and ſhaking them into bags clean and ready for the die. Without any perſonal communication between the different claſſes of workmen, &c. the blanks are conveyed to the room where they are ſhaken, and from thence to the coining-room, in boxes moving with immenſe velocity on an inclined plane, and accompanied by a ticket of their weight.

The Sierra Leone company have employed Mr. Boulton's mint in the coinage of ſilver, and the Eaſt India company in that of copper. Two complete mints have likewiſe been lately ſent to Peterſburgh.

Since the demiſe of the late empreſs Catharine, Mr. Boulton preſented her ſucceſſor, the late emperor Paul I., with ſome of the moſt curious articles of his manufactory, and in return received a polite letter of thanks and approbation, together with a ſplendid collection of medals, minerals from Siberia, and ſpecimens of all the modern money of Ruſſia. Among the medals, which for elegance of deſign and beauty of execution have never yet been equalled in this or any other country, is a maſſy one of gold, impreſſed with a ſtriking likeneſs, it is ſaid, of that monarch. Our readers will be ſurpriſed, when they are told that this unrivalled piece was ſtruck from a die engraved by the preſent empreſs dow-

ager,

ager, who has from her youth taken great delight in the art of engraving on steel.

With the view of still further improving and facilitating the manufactory of steam-engines, Messrs. Boulton and Watt have lately, in conjunction with their sons, established a foundery at Smethwick, a short distance from Soho. Here that powerful agent is employed, as it were, to multiply itself, and its various parts are fabricated and adapted together with the same regularity, neatness, and expedition, which distinguish all the operations of their manufactory. Those engines are afterwards distributed to all parts of the kingdom by the Birmingham canal, which communicates with a wet dock belonging to the foundery.

To such amazing perfection has the steam-engine at length been brought, that the consumption of one bushel of Newcastle coals will raise nearly six thousand hogsheads of water ten feet high, and will do the work of ten horses for one hour. This remarkable abridgement of human labour, and proportionate diminution of expense, are, in a great measure, the result of trials made under the auspices of Mr. Boulton. But for a more complete account of these machines, their power, &c. we must refer the reader to Dr. Darwin's Botanic Garden *.

It could scarcely be expected that envy would view with indifference such singular merit, and such unexampled success. The inventions and improvements of Messrs. Boulton and Watt were first imitated, and then either decried or disputed. Reason laboured in vain to silence the clamours of injustice, and to defeat the stratagems of fraud. At length, in the year 1792, a solemn decision of parliament, and, about the same time, the concurrent opinion of the court of king's bench, forbad any further encroachment.

Whoever contemplates the merit and utility of a long life devoted to such valuable pursuits, as we have here briefly and very imperfectly described, and recollects without emotion, that the spot whereon so much has been done, and is still doing; where hundreds of women and children easily earn a comfortable subsistence †; where population is rapidly increasing, and the means of national prosperity increasing in

* Fourth edit. note xi. page 287.

† We have been unable to ascertain the number of hands employed by Mr. Boulton at this time, which must frequently vary according to the changes that necessarily take place in the demand for different articles; but we know, that when Mr. Boulton junior came of age, in 1791, seven hundred workmen sat down to an entertainment given by his father.

pro-

proportion, was lately a bleak, swampy, and sterile waste, must want understanding to comprehend, or sympathy to appreciate, the happiness of his fellow-creatures.

Mr. Boulton is now in his seventy-third year, and he appears to possess the hilarity of youth. Extraordinary exertions, often both of body and mind, seem not to have impaired a constitution which must have been naturally robust. He is fond of music, and takes great delight in the company of young people. One son, a young man of considerable accomplishment and great promise in his father's line, and one daughter, both of them unmarried, have survived their mother. Mr. Boulton is fellow of the Royal Societies of London and Edinburgh, and of the Free Economical Society of Petersburgh, as well as of many other foreign institutions.

XI. *On the Effects of Elder in preserving Plants from Insects and Flies.* *By* M. Christophe Gullet *.

COMMON elder has appeared to me useful, 1st, for preventing cabbage plants from being devoured or damaged by caterpillars: 2d, to prevent blights, and their effects on fruit- and other trees: 3d, to preserve corn from yellow flies and other insects: 4th, to secure turnips from the ravage of flies, &c.

1st, The strong and fetid odour of a bunch of elder leaves induced me to think that different kinds of butterflies might be incommoded by it in proportion to their delicacy. I therefore took some young twigs of elder, at the period when butterflies began to appear, and whipped well with them some cabbage plants, but in such a manner as not to damage them. Since that time, during two summers, though the butterflies hovered round the plants, I never saw one of them settle on them; and I do not think that a single butterfly was hatched on the cabbages treated in this manner, though a neighbouring board was dirtied by them in the usual manner.

2d, After a short reflection on the effects here mentioned, and on blights, which, in my opinion, are chiefly occasioned by small flies and small insects whose organs are still more delicate than those of the former, I was induced to whip in the same manner with elder twigs, as high as I could reach, the branches of a plum-tree which grew in an espalier. The

* From the *Bibliothèque Physico-économique*, Ann. 6.

whipped

whipped leaves remained green and in a good condition, while from at least six inches above to the top of the tree the rest of the leaves were blighted, wrinkled, and full of worms. It is here to be observed that the tree was in full flower when I whipped it, therefore much too late for this operation, which ought to have been performed once or twice before flowering. But I am of opinion, that if trees were besprinkled with a strong infusion of elder every eight or fifteen days, the success would be certain, and that there would be no danger of injuring either the flowers or the fruit.

3d, What the farmers call the yellows in corn, and which they consider as a kind of blight, is the effect, as every one knows, of a small yellow fly with blue wings nearly of the size of a gnat. It lays its eggs in the ear of wheat, and produces a worm almost invisible to the naked eye, but which, when seen by a magnifying glass, is a large yellow larva, having the shining colour of amber. This fly is so productive, that I have counted upwards of forty worms in the chaff of one ear of wheat, which was a number sufficient to destroy it entirely. I therefore proposed to make my experiment as soon as possible; but the heat and drought of the season having advanced the wheat more than usual, it was in flower before I could attempt it. Next morning, however, at break of day, two servants having drawn bundles of elder over the ears of wheat on each side of the furrow, backwards and forwards, in places where the wheat was not so far advanced, I hoped that the fetid effluvia of the elder would prevent the flies from remaining on the ears that were covered with them: and, indeed, I was not entirely disappointed; for, on examining my wheat some time after, I found that the part which had been beaten with elder was much less damaged than that which had not been treated in the same manner. I have no doubt, that, had I employed this precaution sooner, the corn would have been completely preserved. Should this be the case, the process is simple; and I flatter myself that fine crops of corn may be saved by these means from this small insect, which is so destructive to them. One of these yellow flies laid on my thumb at least eight or ten eggs, of an oblong form, in the small interval of time which I employed in walking over two or three furrows, holding it by the wings, and which I could not observe without the assistance of a magnifying glass.

4th, It often happens that whole crops of turnips are destroyed while young, in consequence of being pricked by certain insects. I have great reason to think that this evil may be prevented in an effectual manner, by causing a person to draw a bunch of elder, sufficiently large to cover about the

breadth

breadth of a foot, over the young turnips, going backwards and forwards. What confirms me in this idea is, that, having drawn a bunch of elder over a bed of young cauliflowers which had begun to be pricked, they afterwards remained untouched by theſe inſects.

Another fact which tends to ſupport this idea is, that when my neighbourhood, about eight or nine years ago, was ſo infeſted with caterpillars that they devoured all the vegetables, leaving ſcarcely a green leaf untouched, they ſpared the elder-trees amidſt this general devaſtation, and never moleſted them. In reflecting on theſe circumſtances, I am of opinion that the elder might be introduced with advantage into our gardens, as the means of preſerving fruit-trees and various plants from the rapacity of inſects.

The dwarf elder appears to me to exhale a much more fetid ſmell than the common elder, and therefore ought to be preferred in making experiments on this ſubject.

XII. *Reply to a Charge of Plagiariſm, brought by Mr.* HENRY CLARKE *againſt* W. DICKSON, *LL. D. Communicated in a Letter from Dr.* DICKSON *to Mr.* TILLOCH.

I HAVE partly drawn up, and hoped before this to have laid before the Public, a Defenſe of Sir Iſaac Newton, and ſome other diſtinguiſhed Britiſh mathematicians, againſt the miſrepreſentations of Mr. Henry Clarke, and of the writer of the mathematical articles of the Monthly Review. But a diſtreſſing complaint, which is alleviated but not yet removed, has, as you know, long rendered me almoſt, and at times altogether, incapable of the neceſſary application to more ſerious concerns, which will demand my whole attention for ſome time to come.

I certainly owe the gentlemen ſome return for their Animadverſions * on one of my notes on C. Carnot's excellent piece on the Infiniteſimal Calculus; and it will be eaſy to repay them in their own coin, and with intereſt. In that inſtance, it is true, and perhaps in others, I unfortunately

* See Animadverſions on Dickſon's Tranſlation of C. Carnot's Reflections on the Theory of the Infiniteſimal Calculus, by Henry Clarke, late *Prælect. Coll. Mancun.* &c. ſold by T. Hurſt, No. 32, Paternoſter Row.—Alſo the Monthly Review Enlarged, vol. xxxviii. p. 440, 441. N. Series.

 miſtook

miſtook the ſenſe of my very acute and ingenious author; for which I am ready to make *him* and my readers any reaſonable apology*. But it is alſo true, as Mr. Clarke himſelf confeſſes, that I "have endeavoured to do juſtice to my author," and, "on the whole, have properly appreciated his merit." Yet it is no leſs apparent, that both Mr. Clarke and the Monthly Critic, not contented, as the Critical Reviewer has been, with correcting my error, have, *without the ſmalleſt provocation*, treated me with the greateſt harſhneſs and contempt. Their motives will appear hereafter, from the internal evidence of their own writings, compared with my notes on C. Carnot; and from ſtrong collateral circumſtances. Among other things, it will appear, that Mr. Clarke, as well as the Monthly Cenſor, is in ſome degree, a critic by trade; that both are in the habit of emitting their deciſions, with an air of deſpotic authority, which ill becomes men whoſe abilities, conſiderable as they are, cannot hide their infirmities, far leſs juſtify their inſolence; and that, in many inſtances, they ought rather to implore pardon, than to provoke recrimination. Mr. Clarke has already been taxed with "*nonſenſe*" in correcting my error†; and the "injurious aſſertions" of the Monthly Critic have lately obliged the juſtly celebrated Dr. Hutton, of Woolwich, to drag the "concealed tyrant" out of his hole, and to expoſe him publicly *by name*.

I ſhall be juſtified by the evidence before me, to conſider my cenſors (eſpecially the Monthly one) in certain *other* lights than thoſe of ſelf-conceited and unjuſt critics, and illogical, new-fangled, mathematicians.—But my chief object at preſent is, to repel a charge of plagiariſm, brought againſt me by Mr. Clarke, in theſe words:

"P. S. The Tranſlator informs the reader, in his note, p. 47, that the general method there ſhown of finding the fluxions of quantities, is "*in ſome meaſure new.*" But if the reader will look into *Clarke's Rationale of Circulating Numbers, with uſeful Remarks on various Parts of the Mathematics*, publiſhed about twenty years ago, he will find the very ſame proceſs adopted, and the application thereof copiouſly exemplified!"

Such is the charge which Mr. Clarke, no doubt to make it conſpicuous, has placed in a Poſtſcript after "the end" of his Animadverſions on my Tranſlation of Carnot; and has finiſhed it with a (!) by way of a ſting to its tail.

* My error cannot embarraſs the reader. He has only to omit my note, p. 26.

† In the Critical Review, vol. xxxiv. New Arr. p. 359.

In the firſt place, I ſolemnly declare that this charge is falſe and groundleſs in every poſſible reſpect.

Secondly, I deny that I have there "ſhown a general method of finding the fluxions of quantities." I have only inſerted in a *note*, "*a ſpecimen*"—"*a ſlight and imperfect general outline*"—*of a very eaſy, and in ſome meaſure new*, manner of treating the fundamental proceſſes of fluxions, which I long ago mentioned to yourſelf; and which, with ſome thoughts on Prime and Ultimate Ratios, I intended to offer you for publication," &c.* The ſubſtance of the paper here alluded to, which you may recollect my mentioning, I ſubmitted to a certain Gentleman whoſe education does honour to the Univerſity of Cambridge. But the paper itſelf, owing to my indiſpoſition and avocations, is not yet finiſhed; and, owing to the treatment I have received, is likely never to be printed, any more than ſome analogous pieces of more conſequence, which I intended for the preſs. This, Mr. Clarke will ſay, perhaps very truly, is no loſs to the public. But unleſs he can divine the contents of a piece, which has no public exiſtence, his charge of plagiariſm muſt become impotent, or can only affect it's fabricator.

Thirdly, Whether even the "ſpecimen" of the method which I *promiſed*, be, or be not, "the very ſame" with Mr. Clarke's, is *a matter of fact*, of which thoſe perſons who compare them can judge; and ſuch I leave to determine, Whether they know any book from which that "ſpecimen" differs ſo widely as it does from that of Mr. Clarke.

I pretended not to a method entirely, or even in a *great* meaſure, new. My principal object was *facility*, which is but too much neglected by great mathematicians. I thought, however, that my firſt way of finding the fluxion of a fraction was my own, as I ſtill think the ſecond is. Certainly, I never received either of them from any man, or from any book. The firſt is as follows:

"The fluxion of a fraction may be found by conſidering it as the product of the numerator and denominator, giving the latter a negative index. Thus $\frac{x}{y}$ is equivalent to $y^{-1} \times x$; and, as the fluxion of xy is $y\dot{x} + x\dot{y}$, ſo the fluxion of $\frac{x}{y}$, or of its equivalent $y^{-1} \times x$, muſt be

$$\left(y^{-1} \times \dot{x}\right) + \left(x \times -y^{-2}\dot{y}\right) = \frac{\dot{x}}{y} - \frac{x\dot{y}}{y^2} = \frac{y^2\dot{x} - yx\dot{y}}{y^3} = \frac{y\dot{x} - x\dot{y}}{y^2}.$$

* See my Tranſlation of Carnot, notes p. 48 and 49.

This procefs, I fay, I took to be my own. But fince Mr. Clarke has rudely forced me to look into his obfcure book, and a great number of better ones which I never before confulted, I find it in the *table*, in which, as he fays, he has "copioufly exemplified" his method; whether intelligibly or not, to beginners, whom he profeffes to inftruct, it is not my prefent bufinefs to inquire.

In Mr. Clarke's firft column, marked "Variable Quantities," ftands "$\frac{x}{y} = xy^{-1}$", and in his fecond column marked "Fluxions, $x \times -y^{-2}\dot{y} + y^{-1}\dot{x} = \frac{y\dot{x} - x\dot{y}}{y^2}$."

Mr. Jones, I find, ftates the fame procefs, thus,

"F, $\frac{x}{y}$ $\left(x \times \frac{1}{y}\right)$ is $\left(\dot{x} \times \frac{1}{y} - \frac{\dot{y}}{y^2} \times x\right) \frac{\dot{x}y - x\dot{y}}{yy}$."*

And Mr. Holliday thus: "What is the fluxion of $\frac{x}{y}$, or xy^{-1}?—1ft, $\dot{x} \times y = y\dot{x}$; and 2d, $\dot{y} \times x = x\dot{y}$: then $\frac{y\dot{x} - x\dot{y}}{yy}$ the fluxion. For $\frac{\dot{x}}{y}$ or $\dot{x} \times \frac{1}{y}$ is $= \dot{x} \times \frac{1}{y} - \frac{\dot{y}}{yy} \times x = \frac{y\dot{x} - x\dot{y}}{yy}$."†

Now, have not I as good a right to fay (what however, I am very far from faying) that Mr. Clarke copied from Jones or Holliday, as he has to affirm, that I copied from him? And, is it not a prefumption in my favour, that I have been more explicit than any of them; although I only offer a "fpecimen" in a *note*, and they profefs, as Mr. Clarke expreffes it, to render the principles of Fluxions "clear to the loweft capacity ‡?"

Be this as it may, in the fame note, I mention a fecond, and ftill eafier, way of doing the fame thing, in thefe words, "The fluxion of a fraction, $\frac{x}{y}$, may alfo be found, but not fo elegantly, by actually dividing $x + \dot{x}$ by $y + \dot{y}$." Of this, which

* Synopfis Palmariorum Mathefeos, printed in 1706, p. 229.

† Introduction to Fluxions, printed in 1777, p. 96.

‡ See Mr. Clarke's Preface, p. xii. Jones and Holliday make the fame profeffion in their title-pages and prefaces; and the latter appears, in general, to have fulfilled it.

which indeed has little to recommend it but it's obvious facility, not being able to find a trace in any author, I may fairly claim it as my own; and, if ſo, may now affirm (what I have not before affirmed) that even my "ſlight and imperfect ſpecimen," and, *a fortiori*, the *promiſed* method itſelf, is "in ſome meaſure new"—the point to be proved.

I remain, Dear Sir,

Truly and reſpectfully yours,

WILLIAM DICKSON.

P. S. My language may be thought ſomewhat ſevere. But thoſe who read the critiques of which I complain, muſt acknowledge, that it is more than juſtified by the provocation. To ſuch perſonal provocation, I have hitherto been an *utter ſtranger*; though, you know, that for ſix years, I laboured to promote, by all the fair, honeſt and legal means in my power, the Abolition of the nefarious African Slave-trade. I do not even except the unprovoked piece of invective which firſt contributed to "drag me into that controverſy *"—one of the moſt angry, and voluminous, which ever agitated this nation.——In what I have farther to write, I ſhall endeavour to preſerve better humour, and to return "dry rubs," rather than dry blows,

"To words far bitterer than wormwood,
"Which would, in Job or Grizzel, ſtir mood."

The ends of ſelf-defence (not to mention here a certain more important end) will be abundantly anſwered by a defence of the illuſtrious dead, whoſe aſhes, as is known to you and others, I have long wiſhed to ſee protected by ſome abler hand, from the profanation of the Monthly Reviewer, in the licentious exerciſe of his *fonction*.——What I mean to publiſh, ſhall be *concluſive* on my part. Controverſy, though I ſuffered no diſcredit in the important one juſt mentioned, has no charms for me; nor ſhall I contend, farther than is abſolutely neceſſary, with men who, for aught that appears, watch for opportunities, and will not be nice about the means, of exalting themſelves, at the expenſe of others. W. D.

* See my Letters on Slavery, p. 4.

XIII. *A general View of the Coal Mines worked in France, of their different Products, and the Means of circulating them. By* C. Lefebvre, *Member of the Council of Mines, of the Philomatic Society, &c. &c.**

I HAD propofed for feveral years to exhibit a view of the refources of France in regard to combuftible foffils. I was defirous of making known, at the fame time, the principal places of confumption, the grand metallurgic eftablifhments, where thefe fubftances are, or might be, employed; and to add to this labour an indication of the localities proper for the creation of new manufactories, according to the union prefented by nature of mineral fubftances, capable of being worked, and of abundance of fuel.

It appeared to me alfo, that, to fill up this fketch, it would be neceffary to include pretty certain data, in regard to the nature and quantity of the refources which the forefts and woods might furnifh for confumption in different parts of the French territory, and particularly in regard to thofe moft interefting to be confidered under the view of large manufactories †.

The information collected by the council of mines for feven or eight years, furnifhed a variety of details and interefting facts in regard to the mineral fubftances known and dug up in our territory. The notes refpecting coal mines in particular were the moft numerous, becaufe the adminiftration of mines, feeling the neceffity of fupplying the diminution of the products of our forefts, and the importance of enfuring conftant activity to our manufactories, by means of coals, had paid the moft ferious attention to this object.

A great many indications, however, required further con-

* From *Journal des Mines*, No. 71.

† A good map of the communications, both by land and by water, pointing out the forefts, coal mines, the turf moffes, and the large manufactories, would be of great value to commerce. It would certainly contribute to give more activity to internal commerce. A map of this kind is wanted, and the conftruction of it appears to be an object worthy the attention of the prefent government.

The council of mines fketched out, in the year 4, a part of this operation on the navigation chart by Dupain-Triel. It contained marks which pointed out the pofition of the coal mines, turf moffes, forges, great founderies, falt works, and fome other large manufactories, refpecting which accurate information had been obtained; but this labour is now very imperfect, becaufe the new departments are not included in this chart, which, on account of the new information obtained fince that period, ought to be added.

firmation, and whole districts of France, which were supposed to be highly interesting, were still imperfectly known in regard to mineralogy. The council had not been able for several years to send out many engineers to explore the country; many of the departments earnestly requested that researches might be made in this manner; and the distribution of these functionaries in the places where their presence was so necessary, could not fail to be one of the first measures of a government whose attention was so zealously occupied with the prosperity of the state *.

As I had the strongest reason to hope that the results of the researches and observations of the engineers of mines would furnish the most valuable materials for the proposed view of our mineral resources, I resolved to wait until their residence in the different departments should have enriched the administration of mines with new information proper for rendering more perfect my proposed labour.

I was besides persuaded that, during that period, the solicitude and enlightened alacrity of the magistrates who compose the general administration of forests, would give more extent and correctness to our knowledge respecting the consistence and products of our woods; that, perhaps, we should even have a map of the forests; and that the work which I projected might still be completed in this very important department.

I confined myself, therefore, to the collecting of notes; to verifying as far as possible, and to extending the first data in the possession of the administration of mines, and to making researches in regard to the existing means of circulation, and those which it would be proper to create, in order to take as much advantage as possible of the materials which were the object of my labour.

But at the moment when peace, restored to Europe, inspired a desire of renewing our commercial intercourse with the neighbouring nations, we endeavoured to examine what really were our wants, and what advantages would arise to us from the reciprocal exchanges which might take place.

Our attention was directed in particular to mineral substances: we knew that before the war they had been a considerable object of importation: coals in particular had been

* In consequence of measures taken this year (an. 10) by Chaptal, the minister of the interior, sixty departments are to be visited and carefully examined by engineers, who will concur with the prefects in the improvements to be made in those parts, and who will give an account of them to government. This is all that could be done with the present number of engineers who can be spared for that purpose.

 brought

brought in great abundance into our territory, though the ufe of that kind of fuel was lefs frequent at that period than at prefent, and much lefs, no doubt, than it will become in confequence of the deterioration of the wood. It was, therefore, of more importance than ever to appreciate properly our new fituation in this refpect, after our increafe of territory, the fruit of the conquefts of our armies. It was neceffary to determine whether we ought to admit among us the products of foreign coal mines; confidering on one hand the quantity of money exported,, and the decreafe or even ftagnation of induftry which might enfue in our national mines; and on the other, whatever was proper for the fecurity and improvement of our manufactures.

All the data proper for the folution of this queftion were fubjected to government. The different opinions pro and contra were defended with that warmth which is always excited by objects of great national importance, among men ftrongly attached to their country, and deeply affected by every thing which ought to have an influence on their deftiny.

Whatever may be the determination of government, we muft rely with confidence on the wifdom of its views, and be affured, that it will not decide without being fully informed on the fubject.

In publifhing at prefent this view of the refources prefented by our coal mines, I have no intention of entering into a difcuffion of the queftion already mentioned: but feveral perfons having urged me to make known, as far as poffible, our riches in this department, I thought that by complying with their requeft I fhould render my labour important in feveral points of view; firft, as fupplying information ufeful to ftatefmen, who might be defirous of details on this fubject, and to the different confumers and to the workers of mines.

I have followed the alphabetical order of the departments; each of them has been reviewed; and from the information obtained I have enumerated all the known mines now worked, thofe fufceptible of being worked, and thofe indications not yet verified which feem to deferve an attentive examination.

I have exhibited as far as poffible the mafs of the productions of the coal mines in each department where they are worked, and the mean price of the coals, both at the mines and in the principal places of confumption.

I muft however obferve, that there are fome departments where the mines are worked in fo irregular a manner, that it was impoffible for me to obtain data fufficiently fatisfactory, either

either in regard to the quantity of coals extracted, or to their value. In that case I have only made known the districts where the coals are found.

To the means of circulation which exist, or those which ought to be established, I have paid particular attention. I have indicated these means as far as possible; and under this point of view in particular I hope my labour may be useful, because, by making known the means of circulation, the public attention may be directed to the transportation and use of our combustible fossils, in places where it has hitherto been supposed that they could not be employed with advantage. With this view I have added to this work a chart, where the means of circulation may be traced out, by corresponding numbers placed in the margin, and by lines drawn or dotted with red, which mark the existing modes of circulation, and those projected, or which it may appear of advantage to establish.

The departments in which no fossil combustibles are dug up have nevertheless been presented in their order; and I have announced whence these substances may be extracted, and the means by which they may be transported.

I have exhibited also a general view of the various considerations in regard to public advantage and economy which result from the present state, as far as it is known, of our resources of mineral fuel.

Department of Ain.

This department exhibits no strata of coals worked at present. At Surjoux, in the canton of Seyssel, on the banks of the Rhine, asphaltes or mineral bitumen is found. It is extracted from beds of coarse granitic freestone, analogous to that which covers certain strata of coal, or which is found in alternate strata with it. Several banks of this bituminous freestone are found all round the commune of Surjoux. They have very little consistence, on account of the abundance of liquid bituminous matter with which they are mixed.

C. Suretan, an inhabitant of Seyssel, who has a grant of a part of those districts, extracts and prepares this mineral bitumen. The products extracted amount annually to about ten thousand myriagrammes. This substance may be employed for daubing over cordage and wood, to defend them from water and from the attack of worms. It is useful also for greasing the axle-trees of carriages, and different parts of machines, to facilitate their rolling.

The means of circulation of these productions are the

 Rhone

Rhone defcending towards Lyons, the South of France, and particularly the fea-ports in that quarter, where the ufe of this bitumen may be attended with economical advantage.

Department of Aifne.

This country contains no coal mines (1) * worked at prefent: a fubftance known under the name of *coal earth* is commonly found in it, forming beds of greater or lefs thicknefs, and generally placed at no great depth beneath the cultivated lands. It is a fort of exceedingly pyritous turf. It burns badly, and cannot be employed for the fame purpofes as real coal: it would be very bad for heating apartments, or for working iron. A great deal of this fubftance, however, is dug up; it is employed by the farmers, who fpread it out, either in its natural ftate, or after it has been left to wafte in the open air, on the fields, which it renders fitter for vegetation.

The abundance of pyrites difperfed throughout the ftrata of turf render them fufceptible, perhaps, of yielding, by proper treatment, fulphate of iron (green copperas). The coal pits of the northern departments will eafily furnifh coal for the confumption of that of Aifne, when the junction canal between the Scheldt and the river Oife fhall be terminated.

Department of Allier.

There are coal mines worked at Noyant, (2) in the commune of the fame name, fituated fix leagues fouth-weft of Moulins, on the edge of the road from that town to Montluçon. At the diftance of three leagues further, proceeding towards the latter place, there is another coal mine now worked; namely, that of Fins, in the commune of Chatillon; and a league and a half further, but on the other fide of the road, a third, that of des Gabliers, in the commune of Tronget.

The coal hitherto extracted at Noyant is that proper for ufing under boilers, and for other purpofes of a fimilar kind. That furnifhed by the mines of Fins and Gabliers is for the moft part of an excellent quality, and proper for forges. The annual product of thefe mines is about a million of myriagrammes; but they are far from being carried to that degree of activity of which they feem to be fufceptible. It is announced that meafures are about to be adopted in regard to the mine of Fins, calculated to obtain from it all the advantages which the depth of the ftrata and the valuable quality

* Thefe numbers refer to the map.

of

of the coals seem to promise. The product of these mines is consumed in the neighbouring glass-houses, and the coals are transported by water down the Allier, on the Loire, the canal of Briare, and the Seine.

A plan has been long in agitation to employ the small river of Quenne to facilitate the transportation of these coals as far as the Allier. If this project be susceptible of execution, there can be no doubt that this mode of communication with the river Allier will be of great importance; for the expense of land-carriage as far as Moulins already doubles the price of the coal. It varies in these mines from six to ten per cent. the myriagramme: it has already risen at Moulins from twelve to twenty per cent.; and when delivered at Paris from twenty-four to forty per cent.

This department exhibits also, in the commune of Commentry, considerable strata of coal of excellent quality, and might be worked with advantage, if a consumption be created for them: this at present is absolutely wanting, and for this reason these mines are very little worked. The engineers of mines who have visited this country have pointed out several new strata not before observed.

The mines of Plaveret and de Bouije furnished in the year 3, a hundred thousand myriagrammes, which is far below the quantity that might easily be extracted. The price at the mine is about four cents per myriagramme.

If the Cher were rendered navigable from Montluçon to Vierzon, where it is so at present, the mines in the neighbourhood of Commentry would soon give rise to enterprises which would enliven that country. It is probable that they would have a very happy influence on the activity of the numerous forges situated on the borders of the Cher, and at a small distance from it, by the application of a fuel so strong as coal to a part of the operations of these forges.

There are indications of coal in several parts of this country which deserve to be examined, if there were easier means of disposing of them, or if consumption could be found for them on the spot. Such are the indications found by C. Rambourg, near the forest of Tronçais, in the canton of Meaulne; and those in the commune of Vallon, in the same canton, discovered by Thiebault of Allier.

Department of the Lower Alps.

Some coal mines (3) are worked in the neighbourhood of Manosque and Forcalquier. They are worked very irregularly. The products are not well known. The quality of the coals is very indifferent. They are sold for about 20 cents

cents per myriagramme, delivered at the mine. There are very few means of difpofing of them.

Department of the Upper Alps.

Coal mines are found (4) in the commune of Saint Martin de Querieres, and in the neighbourhood: the fame obfervations may be applied to thefe coal mines as have already been made in regard to thofe of the Lower Alps. They have however a more certain and an eafier fale, in confequence of the neighbourhood of the town of Briançon, where the confumption is very confiderable, as wood is exceedingly fcarce in that canton.

Department of the Maritime Alps.

A grant was paffed in the year 9, of the coal mine (5) in the neighbourhod of Roquebrune. The grantee has lately announced that the firft attempts were not fuccefsful. It, however, appears that fome of this fuel is dug up in feveral places in the neighbourhood of Monaco. Thefe mines might acquire a certain degree of importance, if the coals were of a good quality, and if they were exported through the port of Monaco, or if manufactories of iron articles were eftablifhed in that department, or in the environs of the mines.

If the iron ore of the mines of Elba was treated in this department, or in that of Var, the iron obtained might give rife to manufactories of this kind; but thefe confiderations require further information, which will no doubt excite the attention of government.

Department of Ardeche.

Coals are found (6) in feveral cantons of this department, and particularly in the environs of Jaujac, Privas, Aubenas, Vallon, and Saint Marcel'd'Ardeche. Thefe mines, in general, are badly worked. They are interefting, however, in different points of view; firft, on account of the confumption occafioned by the numerous manufactories of the country; and in the fecond place of the facility of carriage down the Rhone.

No data fufficiently exact have yet been obtained in regard to the products of thefe mines: they are certainly confiderable, and would become much more productive and profitable, if the works were better conducted. The common price of coals in that country is about 8 cents per myriagramme.

An engineer of mines, if fettled in this department, might introduce improvements in the working of thefe coal mines, which are exceedingly defirable. He could employ himfelf alfo on other objects ufeful to the induftry of the inhabitants.

[To be continued.]

XIV. *On Canals.* *By* THOMAS TELFORD, *Esq.**

INLAND navigation has now been so long and extensively practised in Great Britain, that the benefits arising from it are generally felt and acknowledged; and it is difficult to say, whether the improvements in agriculture, manufactures, or commerce, are most indebted to the numerous canals which now intersect the country in all directions, or to other causes.

It is not my intention at present to trace the rise and progress of this great national improvement, nor to enter deeply into the general principles of it: what I chiefly aim at in this slight sketch is, to draw the attention of the people who are concerned in laying out new canals, to some circumstances which appear to me to be very material to the interests of canal companies and to the country at large.

In considering the subject, I shall beg leave to state, that canals are chiefly for the purpose of,

1st, Carrying fuel and raw materials to some manufacturing towns or districts, and for exporting manufactured goods.

2dly, Carrying fuel for domestic purposes; manure for the purposes of agriculture; transporting the produce of the districts through which the canal passes to the different markets; and promoting agricultural purposes in general.

3dly, Carrying the produce of mines to the sea-shores.

These appear to be the leading points by which our views ought to be guided in planning new canals. The supplying the district through which the canal passes with groceries and merchant goods is a very secondary consideration; experience has taught this lesson to the persons who are concerned in the canals already made; and it is proper this source of disappointment should be made generally known, in order to prevent future misapplication of talents and capital.

In planning a new canal, it should be carefully considered under which of the foregoing heads the uses of the canal ought to be classed. Cases will sometimes, no doubt, occur, where the several purposes above mentioned will in some measure be combined; but they will rarely be so equally balanced, as to create a difficulty in discovering the predominant features. The general purposes of the canal being judiciously determined, all the following steps should be taken with a view to promote the principal end.

If the canal is for the purpose of carrying fuel and raw materials to some manufacturing town or district, and export-

* Communicated by the Author.

ing

ing the manufactured goods from thence, or for carrying the produce of mines to the sea-shores,—the line of canal should be made in as short a direction as the nature of the country will admit of, even if this line should be atttended with some extraordinary expense; and that mode of conveyance should be adopted which is least liable to be interrupted, because in those cases much depends upon a constant and regular supply.

If the canal is chiefly for the purposes of agriculture, those lines are to be sought for which will accommodate the country most perfectly at the least possible expense. This will not, in general, be effected by short and direct, but, on the contrary, by circuitous and level lines, such as will visit many parts of the country, carry fuel and manure into every quarter, and take off the produce of the land for back carriage. Merchandize, although a very inferior consideration, will, by the same means, be extensively and equally distributed. When the carriage of those heavy but necessary articles is rendered cheap, and the supply convenient, the consumption will increase. The very use of lime as a manure is in general sufficient to create a considerable revenue upon a canal, when the coal and limestone can be carried along the canal at a moderate expense. As improvements in agriculture must increase the wealth of the inhabitants, more articles are required to supply their multiplied wants; the possession of capital prompts them to enter upon new employments, and the demands of all create an addition of business upon the canal.

Many other advantages attend circuitous and level canals. If there are upland countries above the level of the canal, some cheap and convenient situations may be selected where the waste water of the uplands can be collected into reservoirs to be formed for this purpose. From those reservoirs the water may be taken into the canals. At various points of the canal, where there are falls immediately on the lower side, mills may be erected for grinding corn, or for the purposes of manufactures: in many parts, two or three overshot wheels, of sufficient diameter, may be placed below each other: when the water has performed those useful offices, it will fall into the brooks, and prove a plentiful and regular supply to other works in the course of each stream.

Improvements in agriculture may also be greatly promoted by using a part of the waste water for the purpose of irrigation. For a canal carried over a country upon a high level would prove an extensive top drain. Not only the land adjoining the banks of the canal, but all which lies below the level, may enjoy the use of the water for irrigation; and the brooks and rivers will be the tail drains of the country.

Collecting

Collecting the waſte water in winter, and in heavy rains, will prove advantageous in every reſpect: it will be the means of preventing high and rapid floods; it will be converting to uſeful purpoſes that which flows off to idle waſte, and, not unfrequently, to poſitive miſchief.

The uſeful purpoſes to which brooks and rivers are now applied, will not be injured, but improved; as there will be a more plentiful ſupply in ſummer, and a better regulated one during the winter months.

Parliament would not heſitate to grant canal companies the power of making reſervoirs, and receiving a reaſonable recompenſe for the water ſupplied from the canal for the purpoſes of agriculture and manufactures, becauſe it would injure no perſon, and accommodate all: it will be furniſhing additional powers to Britiſh induſtry, and creating permanent wealth to the nation.

I underſtand that this mode of managing water has long been practiſed in Italy, eſpecially in the Milaneſe, where a conſiderable revenue is derived by the waſte water of canals; and the regulations reſpecting it have long engaged the attention of the legiſlature of that country.

If I am right in the foregoing ſtatements, it will be eaſy to apply them to different diſtricts of country, and, by a careful and impartial judgment, to decide upon the character of each canal.

It is probably not ſufficiently known what quantity of rain water falls in the courſe of a year in various parts of the kingdom; it therefore may not be improper to add the following ſtatement, which will be ſome guide with regard to this ſubject; and if along with this we take the accounts of perſons accuſtomed to make obſervations, a tolerably correct eſtimate may be formed of the average quantity of water which can be collected in each diſtrict: it will, in general, be found to exceed the expectations of perſons who have not paid attention to this important ſubject.

Rain falls—At London, being the average of the following Years: 1774, 5, 6, 7, 8, 9, 1780; 1789, 90, 91, 92	Inch. 21 $\frac{1}{2}$
Upminſter, in Eſſex, average of 1700, 1, 2, 3, 4, 5	19 $\frac{1}{8}$
Lincolnſhire, in medium ſeaſon - - -	18
Ditto extreme wet - - - -	24
Liverpool - - - - -	34 $\frac{1}{2}$
Townley, in Lancaſhire - - -	42 $\frac{1}{2}$
Kendal, in Weſtmoreland - - -	61 $\frac{1}{4}$
Dumfries, in Scotland - - -	36 $\frac{1}{4}$
Glaſgow, ditto - - - -	31

XV. *Pro-*

XV. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

IN the meeting of Jan. 27th was read a paper by Charles Greville, efq. giving an account of three fpecimens, in different mufeums in France, of ftones which have fallen to the earth from the clouds, all fimilar in their characteriftics to thofe defcribed by H. Howard, efq. and alfo of a mafs of native iron which had fallen in Perfia in the year of the Hegira 1030, according to the annals of the empire written by the emperor, and of which he is ftated to have made fome fabres and daggers: but until other iron was mixed with that of the mafs defcribed the iron was not malleable.

February 3. A paper by Everard Home, efq. on the nature of the tongue, was read. His experiments on different difeafed tongues prove that that member is endowed with lefs irritability than any other organ of the body; and that a difeafed part may be removed with great fafety by means of ligatures.

On the 10th a letter from profeffor Bygge of Copenhagen was read, giving an account of the tranfit of Mercury in November laft.

And on the fame night was begun a paper by Dr. Herfchel on the fame fubject, and alfo on the vifible effects of fudden changes of temperature on the interior of telefcopes; giving fome obfervations on the proper fituations to be chofen for obfervatories.

On the 17th the reading of this paper was concluded.

ANTIQUARIAN SOCIETY.

It appears by a memoir prefented to the Antiquarian Society on the 3d of February by Dr. Raine, that the infcription on the pillar near Alexandria, fo long confidered illegible, has been decyphered. The difcovery was made by captain Leake of the artillery, and captain Squire of the engineers. The impreffion was taken in fulphur; and it feems that it was only when the fun fhone on that fide of the pillar where the infcription is, that any traces of it could be diftinguifhed. By the infcription it appears that the pillar was erected in honour of the emperor Dioclctian.

VACCINE INSTITUTION.

Intelligence has been received at the Vaccine Inftitution through one of its members, that cow-pock inoculation has been introduced at Bombay, where it is in great eftimation.

At

At the Vaccine Inſtitution dinner on Monday Feb. 7th, many viſitors voluntarily entered their names with liberal ſubſcriptions. After dinner among other toaſts were given, The promulgator of the vaccine inoculation, Dr. Jenner; Dr. Pearſon, with due acknowledgments of his ſervices in eſtabliſhing the new inoculation by the evidence of practice.

Dr. Pearſon then took the opportunity, after thanking the company for their honourable teſtimony, to inform them of many particulars concerning the conduct and objects of the inſtitution, which could not be noticed in the report, and gave a moſt pleaſing view of the advantages which individuals had already derived from the cow-pock: but he anticipated the momentous conſequences of univerſal inoculation throughout the united kingdom in two reſpects.

1ſt, In preſerving from 30,000 to 46,000 lives annually; and, 2dly, In a few years *exterminating the ſmall-pox.* To accompliſh theſe views, he contended that laws for the inoculation of every ſubject within a certain period after birth were eſſentially neceſſary, as well as immediate prohibition of the inoculation of the ſmall-pox; that the latter meaſure alone would be quite inadequate; and he maintained that it was not more an infringement on the liberty of the ſubject, to render the cow-pock inoculation univerſal, than to prohibit, as already propoſed, the ſmall-pox inoculation. He obſerved that the number loſt by inoculation for the ſmall-pox was not an object of national importance, as it amounted to no more than ſix to nine per thouſand; but when it was conſidered, that one could hardly ſay there was more danger from the inoculation of the cow-pock than from a puncture with a clean lancet, and that the ſymptoms were uſually very much ſlighter than in the ſmall-pox inoculation, and that by univerſal cow-pock inoculation, the infection of the ſmall-pox muſt be extinguiſhed, which end was obvious by even the univerſal inoculation of the ſmall-pox; it remained only to inſtitute the cow-pock inoculation as propoſed, univerſally.

Dr. Pearſon combated the objections againſt increaſing the population, by ſhowing that the reſources of agriculture and animal food were not underſtood. That the augmentation of the population in France required, as a meaſure of ſafety, attention to the means of increaſing this kind of national wealth;—that the mere waſte in feeding of animals, and in preparing food for man, if taken care of, would be ſufficient to ſupport a conſiderably greater than the preſent population.

Dr. Pearſon illuſtrated his argument in favour of vaccine

inoculation by obſerving, that going through the ſmall-pox in the caſual way, and by inoculation of it, and by exciting the cow-pock in place of the ſmall-pox, was like croſſing a river in three different ways.

1ſt, Swimming or wading over; in which 97 out of a thouſand periſhed.

2d, Going over in boats; by which mode 6 to 9 per thouſand were loſt, and many others were injured in their health.

3d, By means of a bridge; during which paſſage no one periſhes (except from thoſe caſualties which might happen in other ſituations), and by which generally the health was not affected, and when it was ſo it was as frequently amended as made worſe.

ROYAL JENNERIAN SOCIETY.

It gives us pleaſure to announce, that a new Vaccine Inſtitution under the above title has juſt been eſtabliſhed, which we have reaſon to hope, from the extenſive patronage it has received, will eventually extirpate the ſmall-pox, in paving the way to which ſo much had already been done by the Vaccine Inſtitution.

His Majeſty is Patron.
Her Majeſty, Patroneſs.

The Vice-Patrons are,

His Royal Highneſs the Prince of Wales.
His Royal Highneſs the Duke of York.
His Royal Highneſs the Duke of Clarence.
His Royal Highneſs the Duke of Cumberland.

Vice-Patroneſſes.

Her Royal Highneſs the Princeſs of Wales.
Her Royal Highneſs the Ducheſs of York.
Her Royal Highneſs Princeſs Auguſta Sophia.
Her Royal Highneſs Princeſs Elizabeth.
Her Royal Highneſs Princeſs Mary.
Her Royal Highneſs Princeſs Sophia.
Her Royal Highneſs Princeſs Amelia.

ROYAL SOCIETY OF GOTTINGEN.

The Triple Inſcription.

In the ſitting of September 4th 1802, profeſſor Heyne read a memoir on the Egyptian monument with three inſcriptions, of which the following is the ſubſtance:

The

The inscription contains a decree of the assembly of the priests of Memphis, by which they confer on king Ptolemy Epiphanes new divine honours, out of gratitude for the services rendered by him to religion, to its ministers, to the people, and to the state in general. To determine the time and occasion of this decree, is the first point in question, and therefore is the first object treated of in the memoir. Ptolemy Philopator left at his death (Olymp. 144. 1. 2:6 years before the birth of Christ) a son about five years of age. The most contemptible persons, who, under the preceding government, had ministered to the pleasures of Philopator, Agathocles, Agathoclea, and her mother Œnanthe, seized on the government and the guardianship of the young prince: they were followed by Tlepolemus, and afterwards by Aristomenes. In the year 200 before Christ the Egyptians intrusted to the Romans the tutelage of the young king, to protect the empire from the projects of king Philip, and of Antiochus of Syria. This measure produced internal troubles and revolts. When Thoas and the Ætolians had been crushed, it was thought most proper for the public repose to declare the prince, who was then fourteen years of age, major, and to suffer him to govern his affairs himself. The ceremony of the coronation, which is known under the name of *Anacleteria*, Olymp. 145. 4. 197 years before the birth of Jesus Christ, and nine years after the death of Philopator, was celebrated at Memphis. The ninth year is expressly named in the decree. All the Egyptian priests were invited to this ceremony. It appears that during the last years of the king's minority attempts had been made to gain over the people and the priests. Government had granted to the priests in particular a great number of privileges and immunities, and had also been at great expense for their worship and temples. Out of gratitude, the assembly of priests decreed, that in crowning the king (the day even is indicated in the text of the decree, the 4th of the Macedonian month Xantichus, the 18th of the Egyptian month Mechir, in the first half of our March, in the second half of the Olympic year) they should offer their homages to the king, according to the manner usual at that time, by giving him titles, and paying him honours, borrowed from the divine worship. The decree contains an account of all the services which the king had rendered to the empire and the Egyptian priests, and then the new titles of honour decreed to him.

The titles found in the decree are: the lord of kings, the glorious, the pious towards the gods, the conqueror of his enemies, the repairer of the pleasures of life, the lord of the

cycles of thirty years (Κυριος των τριακοντα επηριων). He is styled also the descendant of the gods, (εκγονος Θεων Φιλοπατορων) a title by which is understood his father Ptolemy Philopator, and perhaps his mother. The titles properly so called, which are repeated several times with the name, are: the enjoyer of long life, αιωνοβιος, the favourite of Phtha, the visible god, επιφανης, (and not illustrious, as is usually translated) the beneficent, ευχαριστος, according to the meaning given to this word at that period.

The titles and names of the priests, which are at the head of the decree of the assembly, are: εφ' ιερεως Αετου, τȣ Αετου, Αλεξανδρου και Θεων Σωτηρων, και Θεων Αδελφων, και Θεων Ευεργετων, και Θεων Φιλοπατορων, και Θεου Επιφανους ευχαριστου. It is evident that these were priests of Alexander, of Ptolemy Soter, of Philadelphus Euergetes, of Philopator, of Epiphanes, and therefore of the royal family raised to the rank of deities. The name Αετος, eagle, gives reason to believe, that the case was the same here as with other kinds of priesthood mentioned in antiquity, that the family name was entirely abandoned, and could no longer be named; and that the rank was indicated by a general name. Here a symbolic name, viz. the eagle, seems to have indicated the high priest. A priestess of Berenice, no doubt the spouse of Soter, has the second rank; her name of honour is αλλοφορος. The third place, under the title of a *Canephora*, is given to the priestess of Arsinoe, the wife of Philadelphus. The fourth is occupied by the priestess of Arsinoe, the sister and wife of Philopator. Then comes αρχιερεις, προφηται, και οι εις το αδυτον εις πορευεμενοι, προς τον στολισμον των Θεων, (hence it appears that the statues were dressed or ornamented) και πτεροφοραι και ιερογραμματεις, και οι αλλοι ιερεις, &c. respecting which Jablonski will give some explanations, as well as the learned who make further researches in regard to the explanation of the inscription. In regard to the word πτεροφοραι, one of the members remembered a passage in Clemens of Alexandria, where is found ιερογραμματευς εφων πτερα επι της κεφαλης*. This class therefore was distinguished by a feather on the head, as a mark of honour, which is found also on the Egyptian monuments †.

An account of the benefits conferred by the prince on the priests affords several notices respecting the different kinds of taxes; but it would require too much room to detail the whole of them. They consist partly in pecuniary impositions;

* See Beckmann's History of Inventions, part iv. p. 294.
† See *Admiranda Urbis Romæ*, No. 16. ed. 1693.

and

and partly in contributions in kind. We ſhall however mention thoſe benefits which are connected with hiſtory. Among the ſervices rendered by the king, is the ſiege and capture of Lycopolis. The inſurgents of the laſt years had thrown themſelves into this place, and had fortified it; ſo that the ſiege was attended with difficulties, eſpecially in the *eighth* year (of the government). The Nile had increaſed in an extraordinary degree, and the king was obliged to oppoſe dykes to the water, in order that the ſiege might be continued with advantage. Polybius ſpeaks of the ſiege of Lycopolis *; but he places it in the 4th year of the 148th Olympiad, 185 years before the birth of Jeſus Chriſt, and therefore 12 years later. Vaillant alſo places it in this year. The inſcription evidently contradicts this opinion; but we need only examine with attention the words of Polybius, who ſpeaks of the ſiege of Lycopolis as an event that took place ſome years before.

The honours decreed to the king conſiſt partly in a confirmation of the antient honourable titles, and partly in the addition of a new one, that of protector (or avenger) of Egypt. Πτολεμαιου τȣ επαμυνοντας τῃ Αιγυπτω, which was to be every where inſerted in the ſacerdotal rite, and then a ſtatue was to be erected in all the temples. The ſtatue was to be placed in ſuch a manner, that the ſtatue of the deity of the temple ſhould preſent to it victorious arms. The prieſts were to adore the ſtatue three times a day, in the ſacred proceſſions, when ſmall golden temples (ναοι) were carried about, with ſmall images of the gods. The image of the king was to be carried about in a ſimilar ſacellum.

Some other circumſtances, which require further explanation, the author has reſerved for another opportunity. Unfortunately the inſcription has ſuffered in the lower part. It concludes with theſe words: (σ) τερεου λιθου τοις τε ἱεροις και εγχωριοις και ελληνικοις γραμμασιν και στησαι εν εκαστωι των τε πρωτων και δευτερων (ἱερων).

On the Perſepolitan Inſcriptions.

In the ſame ſitting a memoir was read of M. George Groteſend, entitled: *Prævia de cuneatis quas vocant inſcriptionibus Perſepolitanis legendis et explicandis relatio*; the contents of which are the more aſtoniſhing, as the author is not an orientaliſt, and employed himſelf accidentally in decyphering this writing, hitherto ſo obſcure. The author, who has long exerciſed himſelf in decyphering, in conſequence of

* Excerpt. lib. xxiii. 16.

a trifling diſpute with one of his friends, laid a bet that he would decypher one of the Perſepolitan inſcriptions. He ſucceeded beyond his expectation, and in a few weeks was able to explain the greater part of the inſcriptions, and to communicate details reſpecting the manner in which he proceeded, and concerning his reſults.

The author firſt ſpeaks of the *cuneiform writing* in general, and lays down the following principles: 1ſt, The wedge-formed characters are really letters. On the monuments of Perſepolis there are three ſorts of them, which, for the moſt part, correſpond with each other, as has been remarked by Niebuhr and Munter, and which may be called the firſt, ſecond, and third kinds of writing. The whole three may be clearly obſerved on the vaſe of Caylus *, provided two ſigns only be corrected from ſimilar inſcriptions found in Niebuhr and Le Bruyn. 2d. The wedge-formed figures are alphabetic letters, and not ſyllables or ſigns. In the firſt ſort of letters the end of a word is indicated by a wedge placed obliquely, and in the ſecond, by a perpendicular wedge. If the groupes of figures were ſyllables, we ought to have here words of ten ſyllables, for very often there are ſo many ſigns between two ſeparations of words. In each of theſe kinds of writing there are diſtinguiſhed about forty figures, a number which would be too ſmall for writing in ſigns. 3d. All the wedge-formed inſcriptions proceed from left to right, in a horizontal direction, and not vertically or in buſtrophedon characters, as may be ſeen by comparing the inſcriptions B, D, C, in Niebuhr. It is thence ſeen that this principle, expreſſed perhaps too generally, can be applied only to the inſcriptions of Perſepolis.

In the ſecond ſection, which relates to inſcriptions of the firſt ſort in particular, the author obſerves, that this writing has need of marks proper for the long and ſhort vowels, as in the antient Perſian writing called the Zendic: hence the quantity of forty letters which Niebuhr has already collected. In a word, all the inſcriptions which the author has been hitherto able to explain, relate to Darius the ſon of Hyſtaſpes, and to Xerxes; a circumſtance to which new reſearches have already given a high degree of probability.

In the third ſection the author deſcribes the manner in which he proceeded, and gives his explanations. The ſuppoſitions already mentioned, as well as the analogy of the inſcription of the Saſſanides, gave reaſon to expect in particular the name of king, and titles particularly for Darius and

* Rem. d'Antiq. v. pl. 30.

Xerxes.

Xerxes. The words on which accents are found ought to be titles. By different combinations the author obtained the words *Khſcherche* and *Darheuſch*; by help of the words found, read the other words of the inſcription on the urn of Caylus, and thoſe of B and G of Niebuhr, which he explains according to the Zendic. The dictionaries and grammatical remarks of Anquetil were of great ſervice to him in this labour.

The author has given, as the reſults of his reſearches, an explanation of the inſcriptions on the urn already mentioned, and thoſe of Niebuhr, pl. 24, B, G. He read thus the B of Niebuhr: *Dárheûſch Khſchehiôh eghre. Khſchehiôh Khſchêhiohetchâo. Khſchehiôh. Dahutchao. Goſchlaſphæhe, bûn akheotchoſchoch, áh* ôoo, Môro, *ezuṭchuſch*, that is to ſay, *Darius rex fortis, rex regum, rex daharum (filius) Hyſtaſpys, ſtirps mundi rectoris, in conſtellatione maſculâ* τοῦ *Moro,* τοῦ *Ized.* Moro is one of the twenty-eight conſtellations; the author refers the word governor of the world to Giemſhid, from whom the Perſian kings, the Achemenides, derived their origin.

He read thus the inſcription marked G of Niebuhr: *Khſcherche Khſchêhehiâh eghre. Khſchehiôh. Khſchêhiohetchâo. Darheuſch Khſchehiohêhê. bûn. akheotchoſchôh*, that is to ſay, *Xerxes rex fortis, rex regum* (filius) *Darii, regis ſtirps omnium rectoris.* It is in this manner that the author explains the inſcription found in Le Bruyn, p. 273, No. 133, on the mantle of the king: he even propoſes corrections. He thinks alſo that he can reſtore and correct the inſcription on the window, (ſee in the ſame place No. 134.) What has been here ſaid may enable the reader to form ſome opinion of his labour.

However unexpected this diſcovery may be, it ſeems to deſerve ſome attention: we have reaſon indeed to be on our guard againſt diſcoveries of this kind, becauſe one may be eaſily deceived by poſſible combinations, and by certain ſuppoſitions which may originate in chance; eſpecially when the language affords no certain means of judging of their correctneſs, and when, on the other hand, the language itſelf muſt in ſome meaſure be diſcovered. As the author has not made known his alphabet, and as he has not mentioned whether it be complete for all the inſcriptions of the firſt ſort of writing, and how far he has made reſearches in regard to the other kinds; no opinion can yet be formed of the certainty and extent of the diſcovery. It appears that the author hitherto has employed himſelf chiefly with the inſcriptions of Perſepolis, and we muſt confine to theſe inſcriptions ſome principles too generally expreſſed; namely, that each ſort of

 writing

writing exhibits forty figns, that all the wedge-formed writing has a horizontal direction, and that they are all alphabetic. There is fomething alfo to be rectified in the explanation: *rex dabarum*, for example, as a title of Darius, is not very probable: in regard to *rector mundi*, it might be referred perhaps with more reafon to Ormuzd. But what may give us a prepoffeffion in favour of the author's hypothefis is, that it is founded on what the refearches and obfervations hitherto made, give as the moft probable refult. From thefe indeed we can admit that the buildings of Perfepolis belong to the time of the fucceffors of Cyrus. We may even go further, and conclude that the greater part of the monuments were finifhed under Darius and the following kings; becaufe the fhort duration of the reign of Cambyfes would not have been fufficient for the execution of fuch works.

As the infcriptions are as old as the monuments, they muft be referred to the time of thefe princes. In a word, it is feen that the wedge-formed writing on thofe monuments, and in general where it has a horizontal direction, proceeds from left to right. This circumftance, which was obferved by Niebuhr, is inconteftably proved by a fimilar infcription on ftone found in the French national mufeum at Paris, and which C. Millin has given in the firft number of *Monumens Antiques*, plates 8 and 9. The artift in this infcription has placed infulated wedges, or groupes, or whole letters, for which there was no room, above the lines, or in the fecond column, and always to the right, where the end of the line ought confequently to be. The author's explanation agrees with thefe obfervations. He reads from left to right, and finds in the infcriptions allufions to Darius, Xerxes, and certain points refpecting the worfhip of the magi. The legends which the author has found are confiftent and probable, when confidered hiftorically. They have alfo the greateft analogy with the infcriptions of the Saffanides, a dynafty defcended from the antient Perfian kings, and who endeavoured to re-eftablifh the empire and its religion. As thefe princes on antient coins and monuments are ftyled kings of the kings of Izan, of divine origin, &c. fimilar titles, but more fimple, are found in thefe infcriptions. Time alone can fhow whether the continuation of the author's refearches will juftify thefe explanations.

If the learned fhould fucceed in decyphering the wedge-formed writing, their difcoveries would throw great light on many points of the Afiatic antiquities, becaufe more monuments of this writing are daily difcovered. They may be divided into three claffes. 1ft, The Babylonian, among which are reckoned the bricks of the walls of antient Babylon,

lon, and perhaps ſome other monuments, if the reſearches of Dr. Lichtenſtein do not aſſign to them another period. This writing has a peculiar character, which may be diſtinguiſhed by the name of the *nail-writing**. 2d, The Perſian: the monuments of Perſepolis, ſome gems and vaſes, the ſtone of which C. Millin ſpeaks, and ſeveral others. The writing of the latter has more reſemblance to the point of a dart. It might be called *dart-writing*. 3d, The Egypto-Perſian: to this kind, in all probability, belong the cylindric amulets of hæmatites with wedge-formed letters and figures; and, in particular, a fragment of a ſtone found near Suez, which exhibits wedge-formed letters; and a Perſian head, having on it a hawk's wing. An engraving of it may be ſeen in Denon, from a drawing by general Dugua. This variety of monuments, which is daily becoming more numerous, proves how widely diffuſed the uſe of ſuch letters was at a certain period.

XVI. *Intelligence and Miſcellaneous Articles.*

ANTIQUITIES.

SOME curious and valuable remains of antiquity were lately diſcovered in Iſtria, Dalmatia, and Albania, and have been ſent to Vienna by M. de Carnea Stephaneo, his imperial majeſty's commiſſary in theſe provinces. The articles found are:

1ſt, A torſo of Parian marble, found among the ruins of Salona, in Dalmatia, a league north-eaſt from Spalatro. It is ſeven feet and a half in height, and repreſents a naked warrior ſeated on the trunk of a tree, on which is placed his war dreſs. This ſtatue is in the moſt ſublime Grecian ſtyle. The expreſſion and beauty of the form ſhow that it is the work of one of the firſt maſters of antiquity. The belt exhibits a peculiarity not generally met with in ſtatues of this kind. It is much to be regretted that it is mutilated nearly in the ſame manner as the torſo of the Vatican at Rome.

2d, A Minerva, of Corinthian braſs, found in Dalmatia, near Xa-Oſtrogs, three leagues and a half from the mouth of the Narenta. It is eight feet in height, and perfectly entire. This Minerva is in the Greek coſtume, with a helmet, an ægis, and a Meduſa's head on the breaſt: ſhe holds a lance in the left hand, which is ſomewhat elevated, and a cup in the right. The hair is arranged in the ſame manner as

* For a ſpecimen of this kind of writing, ſee our xith volume.

as is ſtill uſual among the Illyrian women in the interior part of Dalmatia, and among thoſe of Kamtſchatka and on the banks of the Anadir.

3d, A Madona with infant Jeſus aſleep, painted by Aloys Vivarinus, of Murano, on a plaſter ground. This painting, which was finiſhed in 1489, is five feet two inches in height and one foot eleven inches in breadth. It was executed at the time when the art of painting in oil was firſt carried from Flanders to Italy. It proves that Vivarinus, by his delicate and expreſſive pencil, had already carried to a high degree of excellence the art of painting, which was not brought to a ſtate of perfection till the time of Charles V.

4th, A naval battle painted in oil, eleven feet in height and twenty-one in breadth. It is a maſter-piece of Tintoretto. He compoſed it at the requeſt of the ſenate of Venice, who preſented it to the city of Piſano. It repreſents the battle ſaid to have taken place in 1177 between the Germans and the Venetian fleet near Cape de Salvora, in Iſtria, and which was firſt mentioned by Andrew Dandolo, in his Chronicle, two centuries after.

5th, A buſt, painted on marble, of Sanctorius, a celebrated profeſſor of Padua, who died in 1639, and who formed an epoch in the philoſophical hiſtory of medicine.

EARTHQUAKE.

Some obſervations have lately been publiſhed in the German journals in regard to the curious circumſtances which accompanied the earthquake that took place in the province of the Seven Mountains towards the end of October. It was in the low meadows lying towards the north that the phænomena were moſt ſenſible, where deep fiſſures two or three feet in breadth and thirty-five fathoms in length, which divided into ſeveral branches, were formed in a direction from weſt to eaſt. A great deal of very fine ſand of an aſh-gray colour, which emitted a ſulphureous odour, was thrown up from theſe fiſſures. The principal fiſſure, after extending throughout a long ſpace, ſeparated into ſeveral branches, which bent themſelves into ſemicircles towards the weſt, and traverſed a houſe and a ſtable, after piercing the walls at the foundation. The whole country was covered with one or more inches of ſand in the direction of the fiſſures: and perſons who were witneſſes to theſe phænomena aſſert, that at the time of the laſt ſhock the earth opened with a noiſe like that of a muſket ſhot; that a black and ſtrong ſmelling vapour iſſued from the fiſſures, as well as a great deal of water, which ſpouted up with a loud noiſe; and that theſe jets were followed by a great quantity

quantity of ſulphureous ſand. The ground alſo ſunk down in a ſenſible manner. The water which iſſued from the fiſſures was exceedingly ſulphureous, cold, and limpid.

Chemiſts obſerved, that a pound of this ſand diluted in eight pints of water produced no effervefcence, and even gave no precipitate on being mixed with vitriolic acid. The nitrous acid gave the ſame reſult. It was only after its decompoſition, and after gall-nuts were able to produce no change in the colour, that the water became turbid, in ſuch a manner as to ſhow the preſence of the vitriolic acid. By decoction and evaporation ſigns of cryſtallization were obſerved at the ſurface; and, when the evaporation was complete, there remained about eight grains of alkaline matters, two parts of which were Glauber's ſalt, one earthy ſalt, and the other gypſum.

TRANSIT OF MERCURY,

As obſerved at Paris November 9, 1802.

Obſervers.	Interior Contact.			Exterior Contact.		
C. Mechain	0^h	6^m	45.4^s	0^h	8^m	30.4^s
Lalande	0	6	29.0	0	7	56
His nephew and Burckhardt	0	6	43.0	0	8	18
	0	6	49	0	8	19
Meſſier	0	6	49.2			

The above reſults are mean time reduced to the national obſervatory.

Mechain ſaw the planet very well terminated without any aureola, though he always followed its progreſs on the ſun with a teleſcope of three object glaſſes $4\frac{1}{2}$ inches in diameter and 7 feet focus, with which he took 45 diſtances. He had obſerved in the ſame manner the tranſits in the years 1782, 1786, 1789, and 1799.

CHEMISTRY.

1. Brugnatelli has lately obſerved, that by treating paper with the nitric acid, a large quantity of ſuberic acid mixed with oxalic acid is obtained. This ſeems to prove that Fourcroy was right in claſſing cork among the immediate principles of the vegetable kingdom.

2. The ſame chemiſt in a letter ſays, that after a particular examination of wheat, he thinks he has found that vegetable gluten is nothing elſe than animal fibrous matter. It differs indeed from animal gluten or glue, by its inſolubility in cold water, and by the contraction it experiences in warm water. When treated with the nitric acid it ſwells, produces

duces a foamy effervescence, gives out nitrous gas, and dissolves. This solution is decomposed by water, like that of animal fibrous matter, and the white precipitate thence resulting dissolves in ammonia, assuming a dark yellow colour.

3. A discovery of two new principles in sulphureous waters has lately been made by Counsellor Westrumb, of Hammeln, who gives the following details:

"For six years I have been exclusively employed in the analysis of sulphureous waters. I have found an easy and entirely new method of determining what they contain of sulphurated hydrogen and carbonic acid gas; and I have discovered a principle hitherto unknown in these waters, namely, bitumen in combination with sulphurated hydrogen gas and hydro-sulphurated lime. I communicated the detail of this discovery to M. Wurzer. Counsellor Von Crell and Professor Schaub of Cassel saw at my house these new products. These principles are found in the waters of Neuwdorf, Limmen, Rehburg, and Eylse. In the last place, five sulphureous springs, altogether different from each other, a spring of carbonic gaseous water, and one of fresh water, are found in an extent of less than a thousand square feet. Near Buckembourg, the capital of the small country of Leppe, to which Eylse belongs, are found two other sulphureous springs perfectly similar, one of which we sounded to the depth of eighty feet without finding its reservoir. Baths of mud similar to those of St. Amand have been constructed at Eylse: a very considerable quantity of hydro-sulphurated mud, which may furnish baths for several centuries, has been found there."

4. A new gas, sulphurated azotic gas, has been discovered in the mineral waters of Aix-la-Chapelle by M. C. Gimbernat, sub-director of the museum of natural history at Madrid, who gives the following account of it:

"I have just finished my labour on the analysis of the sulphureous waters of Aix-la-Chapelle. I have found that the excipient of the sulphur in these waters is not hydrogen, as has hitherto been supposed and asserted, but azote. These waters contain no sulphurated hydrogen.

"Sulphurated azotic gas is a chemical body, the existence of which has never been suspected. Nature presents it in abundance in the mineral waters of this country.

"Besides sulphurated azote, these waters contain a great deal of pure and free azote interposed, and in the semi-gaseous state."

5. We

5. We are informed by Mr. Paul of Geneva (now in London) that water holding ſulphate of lime in ſolution, and impregnated under preſſure with hydrogen gas, of which it can take up about one-fourth of its volume, after ſtanding ſtopped up for about three months, on being opened was found to contain ſulphurized hydrogen gas. This has been repeated ſeveral times with the ſame reſult. In diſtilled water not impregnated with ſulphate of lime, the hydrogen gas undergoes no change.

How is the ſulphurized hydrogen gas produced? There is plainly a decompoſition effected, not merely of the ſulphate of lime, but of the ſulphuric acid, which parts with a portion of its ſulphur.—What becomes of the oxygen? Does it join the hydrogen, and form water?

The hydrogen gas made uſe of in the above experiments was procured from the decompoſition of water, by applying it to iron expoſed to a high temperature. When obtained by means of ſulphuric acid, water, and iron, in the humid way, it has a different flavour, ſomewhat hepatic.

6. Mr. Paul has mentioned to us another circumſtance, which deſerves to be made known. Water impregnated with hydrogen gas is extremely injurious in dropſical complaints. A gentleman labouring under the dropſy was cured by drinking water impregnated with oxygen gas; but during the cure his ſervant by miſtake had purchaſed ſome hydrogen water. In leſs than 24 hours his malady returned: on finding out the cauſe, and having recourſe to the oxygenated water, the miſchief was ſpeedily remedied.

ANIMAL GALVANISM.

Some curious Galvanic experiments were made on February 18, by profeſſor Aldini, in Dr. Pearſon's lecture-rooms. They were by far more intereſting and ſatisfactory than any we have yet noticed on animals, owing to the pains taken to procure the fitteſt ſubjects for the operations. They were inſtituted in the preſence of his excellency the ambaſſador of France general Andreoſſi, lord Pelham, lord Roxburgh, lord Caſtlereagh, lord Hervey, the honourable Mr. Upton, Mr. Cholmondely, Mr. Anchora, Mr. Elliot, and ſeveral other gentlemen of rank. The profeſſor was aſſiſted ably, as on former occaſions, by Mr. Carpue, Mr. Cuthbertſon, and Mr. Hutchins.

Among other important facts, it was deciſively ſhown,

1. That a vital attraction ſubſiſts between a nerve and muſcle: for the ſuſpended ſciatic nerves of a frog, after detaching

taching the ſpine, being brought near the intercoſtal muſcles of a dog, while the aſſiſtant who held the frog did, with his other hand, touch the muſcles of the thigh of the dog, (thus forming a circle); in this ſituation, the nerves ſuſpended approached, and came into contact with the muſcle, as evidently as a ſilken thread is attracted by ſealing-wax.

2. The heart of a rabbit was excited to action in a little time after the animal was killed; but vitality diſappeared much ſooner than in the other muſcles: ſo that this organ is the *primum*, and not, as Harvey aſſerted, the *ultimum moriens*. The lungs, liver, and ſpleen could not be excited to action, even immediately after the animal was killed.

3. The moſt important fact of all was that of exciting contractions by making a circle of nerves and muſcles of different animals, without any metallic exciter or conductors.

4. The head of an ox, recently decapitated, exhibited aſtoniſhing effects: for, the tongue being drawn out by a hook fixed into it, on applying the exciters, in ſpite of the ſtrength of the aſſiſtant the tongue was retracted, ſo as to detach itſelf, by tearing itſelf, from the hook: at the ſame time a loud noiſe iſſued from the mouth by the abſorption of air, attended by violent contortions of the whole head and eyes.

After the exhibition of theſe phænomena of Galvaniſm, which, among other philoſophers, particularly occupy the attention of the Firſt Conſul, the company partook of an elegant *dejeune* and a *converſazione* in Dr. Pearſon's houſe.

XVII. *Deſcription of Mr.* PEPYS'S *large Galvanic Apparatus.*

MR. PEPYS jun. has lately conſtructed the moſt powerful Galvanic apparatus that has, we believe, been yet produced, of which we ſhall endeavour to give our readers ſome idea. It conſiſts of 60 pairs of zinc and copper plates diſpoſed in two troughs conſtructed on Mr. Cruickſhank's plan, but with ſome accompanying arrangements which are extremely convenient and uſeful. That our deſcription may be the better underſtood, we refer to a view of the apparatus, Plate I.

A A. The two troughs, each conſiſting of 30 pairs of plates. The plates are cemented into troughs made of mahogany, properly varniſhed to ſtand the action of the fluids which may be introduced into the cells between the plates. The plates are each 6 inches ſquare, or contain 36 ſquare inches of ſurface on each ſide; and that they may be able to conti-

nue in uſe for a conſiderable time even with the application of ſtrong acidulous liquors, they are made of ſuch a thickneſs that each pair weighs four pounds. The troughs are furniſhed with pivots at each end, by which they reſt on the bar B of the table into which the whole apparatus is framed: on theſe pivots, which are ſo placed as to throw the centre of gravity of the troughs below them, the troughs revolve when it is neceſſary to empty the cells.

C. A japanned iron tray or receiver, capable of holding the contents of the cells of the troughs when they are emptied.

D. A range of ſix funnels made of tin, the diſtances of the tubes of which are ſo adjuſted that they enter ſix of the cells of the troughs at once.

E. A tin veſſel having ſix diſtinct cells with ſpouts, each capable of containing the exact quantity of fluid neceſſary to fill a cell of the trough.

By means of the funnel D and veſſel E, the troughs are filled with very little trouble, no more being neceſſary than to fill the veſſel E by dipping it into the fluid or acid, and then emptying it, by the ſpouts correſponding with the diviſions in the funnel D, into the latter, the pipes of which are placed in the correſponding cells of the troughs.

FF the two prime conductors, being two braſs rods with ſhoulders. They paſs through holes in the top of the table (which, to ſhow the arrangement of the troughs, appears elevated in the engraving) into the end cell of each trough.

G G two metallic conductors, each conſiſting of two parts joined by ſockets, and each having a ſocket which fits upon the prime conductors F F. By this contrivance they are movable in any direction required in the experiments.

H H two ſhallow veſſels made of tin, with tubes underneath, by means of which they can be placed on the tops of the conductors. When filled with water they are found convenient for giving the Galvanic ſhock in a very perfect manner, and for other experiments.

I, an arch of metal to unite the troughs at their further ends.

When the cells are filled, the troughs connected by the metallic arch, the top or lid ſhut down, and the prime conductors put in their places, the apparatus forms a Galvanic table free from any incumbrance, and extremely well adapted for every experiment in Galvaniſm.

On the 21ſt of February, with a number of ſcientific gentlemen, we witneſſed a trial of this apparatus. The experiments

ments made by Mr. Pepys on the deflagration of metals were the moſt brilliant and ſplendid we ever beheld.

The troughs were filled with 32 pounds of water mixed with two pounds of concentrated nitrous acid. With this charge—

Iron wires of $\frac{1}{200}$ to $\frac{1}{10}$ of an inch in diameter were deflagrated with great ſplendour. A number of the ſmall ones twiſted together produced ſomewhat like a little bruſh: a pleaſing appearance in deflagration.

Charcoal of box wood was not only deflagrated at the place of contact, but remained permanently red hot for near two inches in length.

Lead foil burnt with great vividneſs, becoming red hot, and emitting a ſmall volcano or adjutage of red ſparks along with the flame.

Tin foil burnt with great ſplendour, with ſmoke and ſparks.

Dutch leaf or braſs foil deflagrated vividly, with ſmoke and a profuſion of ſparks.

Silver leaf burnt with an intenſe vivid green light: no ſparks, but much ſmoke or fume.

Gold leaf deflagrated with bright white light and ſmoke.

Tin wire, 1-eighth of an inch in diameter, fuſed, burnt, and oxidated, with great ſplendour.

Platina wire, 1-ſixteenth of an inch in diameter, became red hot, white, and fuſed into globules at the contact.

Gunpowder, phoſphorus, and inflammable ſubſtances, are inſtantly fired by contact with conductors armed with charcoal.

The Galvanic power was capable of deflagrating charcoal, after paſſing through ſixteen perſons with wetted hands joined.

The beſt method of ſhowing theſe experiments is by introducing into an earthen plate filled with clean mercury, one of the prime conductors. The other conductor may be then mounted with the ſeveral ſubſtances to be tried. The leaves and laminæ of metal eaſily adhere to it by wetting. Wires may be twiſted round it, and will alſo ſerve to bind other ſubſtances to it.

The power of this large trough was ſo great as to keep up the deflagrations and combuſtion without intermiſſion.

XVIII. *An Essay on the Method of determining the Difference of Longitude between Places at Land, from the observed Transits of the Moon over their Meridians; with a Demonstration and Example.* By Mr. GAVIN LOWE *.

Ea est methodorum simplicissimarum ratio atque natura, ut postremæ in mentem veniant, et nisi obstinatiore animo, ne veniant quidem.

BOSCOVICH.

ALTHOUGH the method of determining the difference of longitude at sea from the lunar observations has been accurately laid down by Dr. Maskelyne and other able nautical astronomers, it has, however, happened that several writers on longitude and astronomy have, in the course of the last twenty years, given rules for finding the difference of longitude at land from the moon's transits, either so erroneous or imperfect, that the adoption thereof might do a serious injury both to navigation and geography: they have given examples, but no demonstrations; or at least such obscure and imperfect ones, as prove that they had not a clear conception of the matter.

It is for these reasons that the following demonstration of a rule both easy and accurate for finding the difference of longitude, is now proposed. The data are the observed increase of the moon's right ascension in passing from the first to the second meridian, and the increase of the sun's and moon's right ascension in twelve hours apparent time, which may be had from the Nautical Almanac.

DEMONSTRATION.

Let the circle A B C represent the equator, P its pole, and A P D the first meridian, as that of Greenwich. Suppose that the centres of the sun, the moon, and a fixed star are on that meridian at the same moment of time as represented at A, and that they move from thence to the westward with their respective velocities, the earth being considered as at rest. Then, after twelve hours apparent time, the sun will be at D, the opposite point to A, or 180° distant from it; but the fixed star, moving in appearance over a greater space than 180° in twelve hours apparent time, will be at E; while the moon, with a motion apparently slower than the sun and the star, will appear after twelve hours at the point B, or on a meridian B P. But E D is the distance of the sun from the star after

* Communicated by the Author.

after an interval of twelve hours apparent time, and E B the diſtance of the moon, or, in other words, the increaſe of their reſpective right aſcenſions: and ſince E D and E B are known from the Nautical Almanac, if we ſubtract the firſt from the laſt, we have D B, equal to the difference between the increaſe of the ſun's and moon's right aſcenſion in twelve hours apparent time. Now the difference of longitude between the two meridians A P and B P is the arc A β B, equal to A β D leſs the arc D B; that is, equal to 180° leſs the difference between the increaſe of the ſun's and moon's right aſcenſion in twelve hours: and, ſince the increaſe of the moon's right aſcenſion from the time of its paſſing the meridian A P to the time of its paſſing B P is known from obſervation, and equal to E B, we can make the following proportion for finding the difference of longitude between any other two meridians, A P and β P, from the obſerved increaſe of the moon's right aſcenſion $\varepsilon\beta$.

As $EB : A\beta D - DB :: \varepsilon\beta : A\beta$ the difference of longitude; or, in more familiar language, as the increaſe of the moon's right aſcenſion in twelve hours apparent time is to 180° or 12^{h} leſs the difference between the increaſe of the ſun's and moon's right aſcenſion in that time ::, ſo is any other obſerved increaſe of the moon's right aſcenſion between two meridians : to their difference of longitude. Q. E. D.*

If the increaſe of the moon's right aſcenſion in twelve hours were uniform, or ſuch that equal parts of it would be produced in equal times, the above rule would be ſtrictly accurate; but as that increaſe ariſes from a motion continually accelerated or retarded, and ſeldom uniform but for a ſhort ſpace of time, it will therefore be neceſſary to find the mean increaſe of the moon's right aſcenſion when it is at the intermediate point between A and β, in order to determine their difference of longitude with the greateſt preciſion; and for that purpoſe, Taylor's Tables of Second Difference are very uſeful.

EXAMPLE.

April the 8th, 1800, the tranſit of the moon's firſt limb was obſerved at the royal obſervatory (A); and, allowance being made for the error of the clock, its right aſcenſion

was - - - - -	12^{h}	35^{m}	$18{\cdot}22^{s}$
Add the time that the moon's ſemi-diameter took to paſs the meridian -	0	1	8·38
Right aſcenſion of the moon's centre	12	36	26·6

* Demonſtrated for the firſt time by the author in 1770.

On

Brought over	12h 36m 26·6s
On a meridian (β*) far to the westward the transit of the moon's first limb was observed the same day, and being reduced to the centre, its right ascension was -	12 47 56·7
Increase of right ascension between A and β - - - -	0 11 30·1
The increase of the moon's right ascension in twelve hours apparent time per the Nautical Almanac was - - -	0 26 3 †
The increase of the sun's in the same time	0 1 49·65
Difference - - -	0 24 13·35

And 12 hours minus this difference is $= 11^h\ 35^m\ 46{\cdot}65^s$; therefore, As $26^m\ 3^s : 11^h\ 35^m\ 46{\cdot}65^s :: 11^m\ 30{\cdot}1^s$ to $5^h\ 7^m\ 12^s$, the correct difference of longitude between A and β.

By reducing the three terms to seconds, and using logarithms, the operation is much shortened.

In a book published by Mr. Mackay on longitude about fifteen or sixteen years ago, there is a rule given, and also an example, for finding the difference of longitude at land from the transits of the moon, but no demonstration. The rule, when divested of its high-sounding enunciation, runs thus:

As the increase of the moon's right ascension in twelve hours apparent time : is to 180° ::, so is any other observed increase between two meridians : to their difference of longitude. It follows from this, that the moon as well as the sun would, in twelve hours apparent time, pass over an arc of 180°, although the apparent motion of the moon to the westward in twelve hours, or 180° of space, be less than that of the sun by six or seven degrees; and so much error would this method produce, if the two places differed about 180° in longitude.

The above example, wrought according to Mackay's rule, would come out thus:

As $26^m\ 3^s : 12^h :: 11^m\ 30{\cdot}1^s$ to -	$5^h\ 17^m\ 53{\cdot}7^s$
But the correct difference as above is -	5 7 12
Error - -	0 10 41·7

which amounts to more than $2\frac{1}{2}$°, or 150 miles, in a difference of longitude little exceeding five hours.

* A place near Port-Royal, in Jamaica.

† By interpolation $26^m\ 3{\cdot}67^s$; but the fraction of the second was not minded.

Mr. Edward Pigott adopts the very ſame rule for determining the difference of longitude between Greenwich and York, and ſtates the reſult in the Philoſophical Tranſactions for 1786, p. 417.

Mr. Vince has inſerted this rule and example in his Treatiſe of Practical Aſtronomy; but we have to regret that they were not accompanied with a ſtrict demonſtration.

The Rev. Mr. Wollaſton, in the appendix to his Faſciculus Aſtronomicus, publiſhed two or three years ago, has given a rule, without demonſtration or example, for finding the difference of longitude from the moon's tranſits, which produces the ſame error as Mackay's and Pigott's, although worded differently from theirs. Mr. Wollaſton makes the firſt term of his proportion apparent, and the third mean time; this renders the reſult erroneous. Since the motion of the ſun, moon, and planets are computed for apparent time, and given ſo in the Nautical Almanac, mean time is not at all requiſite for reſolving the difference of longitude either at ſea or at land. We ſhall therefore endeavour to apply Mr. Wollaſton's rule, according to its literal meaning, for finding the difference of longitude from the above obſervations.

The right aſcenſion of the moon's centre on the meridian of Greenwich being known, we can eaſily deduce the mean and apparent time correſponding to it; and in like manner the mean and apparent time at the diſtant meridian β*. The apparent and mean time of the tranſits of the moon's centre over the meridians of A and β, when ſtrictly computed, were as follows:

	Apparent Time.			Mean Time.		
At A - -	11^h	26^m	$47{\cdot}81^s$	11^h	28^m	$33{\cdot}5^s$
At β - -	11	37	29·5	11	39	11·4
Time later at β than at A	0	10	41·69	0	10	37·9

From the increaſe of the moon's right aſcenſion in twelve hours - -	26	3
Subtract the increaſe of the ſun's right aſcenſion in that time - -	1	49·65
The moon's retardation in twelve hours - -	24	13·35

* Mean time, however, at β, before its longitude be known, is not a fair poſtulatum. The method above demonſtrated does not require it.
G. L.

Then,

Then, "As twice the moon's retardation in twelve hours : is to twenty-four hours : :

"So is the mean time later at β than at A : to the difference of longitude west from A."

After doubling $24^m\ 13{\cdot}35^s$, and also 12, which is totally unnecessary, as the result would be the same if they stood single, we state the following proportion:

As $48^m\ 26{\cdot}7^s : 24^h :: 10^m\ 37{\cdot}9^s$ to--$5^h\ 15^m\ 1{\cdot}3^s$, the difference of longitude between A and β.

But as the third term is improperly reduced to mean time, we shall take the apparent time above found, and then $48^m\ 26{\cdot}7^s : 24^h :: 10^m\ 41{\cdot}69^s$ to--$5^h\ 17^m\ 53{\cdot}7^s$; the same as results from Mackay's and Pigott's rules.

We shall only remark, that $5^h\ 17^m\ 53{\cdot}7^s$ is the apparent time that the moon took in passing from the meridian of A to the meridian of β; but from what has been demonstrated, the apparent time at β will be equal to the difference between the increase of the sun's and moon's right ascension in that interval of apparent time; for DB, or $24^m\ 13{\cdot}35^s$ is the difference for twelve hours, and therefore by proportion $\delta\beta$, or $10^m\ 41{\cdot}69^s$ will be the difference for $5^h\ 17^m\ 53{\cdot}7^s$; subtracting the former from the latter, we have $5^h\ 7^m\ 12^s$, the difference of longitude as before, and a clear proof that the authors above mentioned have omitted to deduct the apparent time at the distant place or station β, from the apparent time at Greenwich.

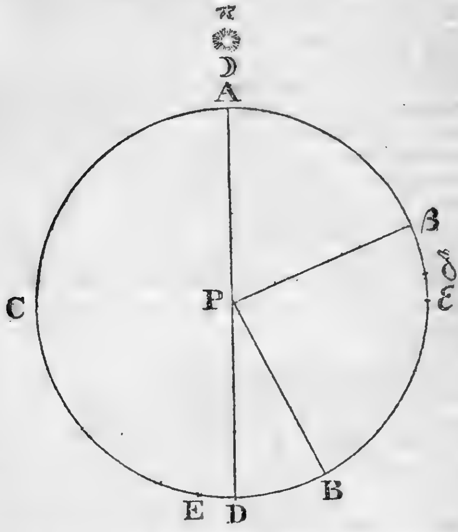
If it should be thought easier to employ sidereal time in resolving the difference of longitude between A and β, let ED, the increase of the sun's right ascension in twelve hours, be added to twelve hours, and we have then the arc of sidereal time ABDE; from which subtracting EB, there remains $A\beta B$, equal to the difference of longitude. By proportion we can therefore say, As EB, the increase of the moon's right ascension in twelve hours; is to ABD + DE, or twelve hours + the increase of the sun's right ascension; so is any other observed increase of the moon's right ascension as $\varepsilon\beta$; to the arc of sidereal time $A\beta\varepsilon$; and if from this we subtract $\varepsilon\beta$, then $A\beta$ is the difference of longitude required.

To apply this rule for finding the difference of longitude from the above observations and data, we say,

As $26^m\ 3^s : 12^h\ 1^m\ 49{\cdot}65^s :: 11^m 30{\cdot}1^s$ to $A\beta\varepsilon$	5^h	18^m	$42{\cdot}1^s$
From this subtract $\varepsilon\beta$, the observed increase	0	11	$30{\cdot}1$
The difference of longitude between A and β is	5	7	12

Q. E. I.

Although we can ſafely truſt to the accuracy of the obſervations at the royal obſervatory, yet, at the diſtant ſtation β, great attention muſt be paid in adjuſting the tranſit inſtrument truly to the meridian, and taking care that it be perfect in collimation before the moon's tranſit be obſerved there; and alſo, that correct time be deduced as ſoon before or after the moon's tranſit as poſſible, from obſerving the meridian paſſage of one or more of the thirty-ſix ſtars, whoſe right aſcenſions, after a long ſeries of obſervations, have been aſcertained by the Aſtronomer Royal with the greateſt preciſion.



In order to put the above method to the teſt of experiment, a number of tranſits of the moon's firſt limb were obſerved many years ago at a place 26 ſeconds of time weſt from the royal obſervatory, with a ſmall portable tranſit inſtrument made by that eminent artiſt Mr. Edward Troughton, of Fleet-ſtreet. It had a teleſcope 20 inches long, a treble object-glaſs, and the price only 20 guineas. When the obſervations at Greenwich were publiſhed, all thoſe that were made on the ſame days at both places were employed to determine the difference of longitude, and the mean reſult of four or five correſponding obſervations gave it true to two ſeconds of time.

This is only mentioned to ſhow, that with ſmall tranſit inſtruments well conſtructed, and due attention paid to their adjuſt-

adjuſtments, obſervations may be made ſufficiently accurate for anſwering the ends of practical aſtronomy.

We expect ſoon to have the lunar tables brought to a greater degree of perfection, by applying certain equations that have been lately diſcovered, and by which thoſe purpoſes will, of courſe, be more ſucceſsfully promoted. It is alſo much to be wiſhed that the moon's tranſits were as aſſiduouſly obſerved by public and private aſtronomers in every country as they are at the royal obſervatory in this, and from time to time communicated to the public at large.

It ſometimes, but not very frequently, happens, that favourable weather will permit one aſtronomer to obſerve four tranſits of the moon over his meridian in the ſame number of ſucceeding days. If another, or indeed a hundred others, ſhould obſerve only one or two on any of thoſe days, whether at the neareſt or remoteſt ſtations from the firſt meridian; ſuch obſervations are of great value, and afford the very beſt means of finding the difference of longitude with accuracy, becauſe the errors of the lunar tables are thereby completely obviated.

Paradiſe Row, Iſlington,
February 14, 1803.

XIX. *On the Preparation of the Hyacinthus non ſcriptus, or common Blue-Bell, as a Subſtitute for Gum-Arabic.* By Mr. THOMAS WILLIS, *of Lime-Street, London* *.

IN the year 1794, whilſt collecting plants in a wood for botanical ſpecimens, I obſerved that the root of the *hyacinthus non ſcriptus*, the plant commonly called blue-bells, or hare-bells, was extremely mucilaginous; and, on taſting it, I diſcovered only a very ſlight pungency. I collected a pound of the bulbs, and, after ſlicing and drying them before a fire, they yielded about four ounces of powder. I thought that, by keeping the powder ſome time, the little acridneſs might go off, as it does in the arum-root powder. I taſted it about ſix months after, and found it perfectly inſipid. I concluded it might be rendered uſeful for food or nouriſhment, but at that time purſued the matter no further.

In the ſpring of 1800, gum-arabic having been a long time very dear, and likely to continue ſo, I thought this mucilaginous root might anſwer ſome of its purpoſes for external uſe. I therefore procured ſeven pounds and a half of

* From the *Tranſactions of the Society for the Encouragement of Arts, &c.* vol. xx., who voted a ſilver medal to the author for his communication.

the bulbs, which, when sliced and dried, produced two pounds of powder. Being soon afterwards in company with Mr. Charles Taylor, secretary to the Society of Arts, &c. I mentioned to him that I had discovered a root which grew in great plenty in this kingdom, yielded a very strong mucilage, and which I imagined would answer the purposes of gum-arabic in some of the manufactories. He said, if I pleased, he would send some of it down to Manchester, to be tried by the calico-printers.

Three or four ounces of the powder were given him, and sent down there: he was informed, upon trial, that it answered the purposes of fixing the calico-printers' colours equally as well as gum-arabic; and in the same proportion, of an ounce and a half of the powder to four ounces of the mordant. Mr. Taylor received the samples of the printed cottons on which it had been used.

On the 15th of January 1801 I furnished Mr. Taylor with eight ounces more of the powder; but have not since heard the result.

As this root can be easily procured, and used at a less price than gum-arabic has been sold for several years past, I think it may be rendered of great utility; and the Society of Arts, &c., by patronizing it, may be the means of making it a public benefit.

Care should be taken, and advice given, that the woods should not be left destitute of the roots; and it would be adviseable to offer premiums for cultivating the roots and offsets, as they are very increasing. By such means a constant supply may be had, if the roots answer the intended purposes.

I do not presume to offer any thing respecting the mode in which the society may think proper to divulge the discovery, and promote the use of these roots; but I imagine, that if the roots are bruised and used fresh, they would answer the purpose better than when dried and powdered; and as it is now a proper time of the year for taking them up, and will continue to be so for two months, I wish that the discovery may be made known as soon as possible.

I have sent you specimens both of the dried roots and powder, that they may be seen at the society's rooms by the calico-printers. What I have done have been scorched a little in drying; but the colour would be much better, if proper care was taken in drying them. I am, &c.

Lime-street, THOMAS WILLIS.
March 17, 1802.

From the trials made before the committee with this powder with hot and cold water, from samples of the printed cotton

ton produced which had been printed therewith inſtead of gum-ſenegal, and from experiments made in Mancheſter, it appears that the *hyacinthus non ſcriptus* may, in many caſes, be found a uſeful ſubſtitute for gum-arabic.

XX. *On the Edulcoration of Fiſh-Oil.* *By* ROBERT DOSSIE, *Eſq.**

Explanation of the Principles on which the Purification of Fiſh-Oil may be performed, and of the Uſes to which it is applicable.

THAT the fœtid ſmell of fiſh-oil is chiefly owing to putrefaction, it is unneceſſary to ſhow; but, though this be the principal cauſe, there is another likewiſe, which is, uſtion, or burning the oil, occaſioned by the ſtrong heat employed for the extracting it from the blubber of the larger fiſh, and which produces a ſtrong empyreumatic ſcent that is not always to be equally removed by the ſame means as the putrid ſmell, but remains ſometimes very prevalent after that is taken away.

In order to the perfect edulcoration of oils there are conſequently two kinds of fœtor or ſtink to be removed; viz. the putrid, and the empyreumatic: and the ſame means do not always equally avail againſt both.

The putrid ſmell of fiſh-oil is of two kinds: the rancid, which is peculiar to oils; and the common putrid ſmell, which is the general effect of the putrefaction of animal fluids, or of the vaſcular ſolids, when commixed with aqueous fluids.

Fiſh-oil has not only rancidity, or the firſt kind of putrid ſmells peculiar to oils, but alſo the ſecond or general kinds; as the oil, for the moſt part, is commixed with the gelatinous humour common to all animals, and ſome kinds with a proportion of the bile likewiſe; and thoſe humours putrefying combine their putrid ſcent with the rancidity of the oil, and, in caſes where great heat has been uſed, with that and the empyreuma alſo.

The reaſon of the preſence of the gelatinous fluid in fiſh-oil is this: that the blubber, which conſiſts partly of adipoſe veſicles, and partly of the membrana celluloſa, which contains

* From the *Tranſactions of the Society for the Encouragement of Arts, &c.* vol. xx. So far back as the year 1761 the ſociety voted him a bounty of one hundred pounds for this communication, though they did not publiſh it till 1802.

tains the gelatinous fluid, is, for the most part, kept a considerable time before the oil is separated from it, either from the want of convenient opportunities to extract the oil, or in order to the obtaining a larger proportion; as the putrid effervescence which then comes on, rupturing the vesicles, makes the blubber yield a greater quantity of oil than could be extracted before such change was produced; and the vesicles of the tela cellulosa, containing the gelatinous matter, being also burst from the same cause, such matter being then rendered saponaceous by the putrefaction, a part of it mixes intimately with the oil, and constitutes it a compound of the proper oleaginous parts and this heterogeneous fluid.

The presence of the bile in fish-oil is occasioned by its being, in many cases, extracted from the liver of the fish; which is not to be so profitably done by other means as by putrefaction; and the bile being consequently discharged, together with the oil from the vessels of the liver containing them, combines with it, both from the original saponaceous property of bile, and from that which it acquires by putrefaction.

This holds good particularly of the cod-oil, or common train, brought from Newfoundland, which, from its high yellow colour, viscid consistence, and repugnance to burning well in lamps, manifests sensibly the presence of bile and the gelatinous fluid; which latter, by the saponaceous power of the bile, is commixed in a greater proportion in this than in any other kind of fish-oil.

A tendency to putrefy, or at most but in an extremely slow manner, is not an absolute property of perfect oils in a simple or pure state, but it is a relative property dependent upon their accidental contact or commixture with the aqueous fluid. This is evident from the case of oils concreted into a sebaceous form; which being perfectly oleaginous and uncombined with any water, except such as enters into their component parts, will not putrefy unless water, or something containing it, is brought in contact with them. But the fluid animal and most vegetable oils being compounded of perfect oils with other mixed substances, either sub-oleaginous or gelatinous, have always a putrescence *per se*, or tendency to putrefy, without further admixture of aqueous moisture. This commixture of heterogeneous matter in fish-oil, particularly of the gelatinous fluid and bile, gives rise to a further principle of purification than *simple edulcoration*, or the removing the fœtor; for the presence of such humours in the oil renders it subject to a second putrescence *per se*, supposing the first corrected; makes it unfit for the purpose of the woollen

manufacture,

manufacture, as the heat through which this is in some cases employed causes this matter to contract a most disagreeable empyreuma. It also prevents its burning in lamps, as well from its viscidity as from the repugnance which the presence of water gives to all oleaginous matter. It is therefore necessary to free the oil from this heterogeneous matter; after which it can be subject only to the rancid putrescence, or that which is proper to oils as such.

The substances which have been or may be applied to the removing or preventing the effects of putrescence, are, acids, alkalies, metallic calces, neutral salts, ethereal and essential oils, vinous spirits, water, and air. With respect to acids, though they may be applied with effect to the removal or prevention of putrefaction in mixed animal and vegetable substances, yet they have not the same efficacy when employed in the case of oils; for in a small proportion, without the subsequent aid of alkalies, they rather increase than diminish the fœtor, and in a large proportion they coagulate the oils, and change their other properties as well as their consistence. Though they might therefore be employed with the assistance of alkalies, yet, requiring a more expensive and complex process, and not being moreover necessary, as the same end may be obtained by the use of alkalies only, they may be deemed improper for the purification of animal oils for commercial purposes. Alkaline substances, both salts and earths, are the most powerful instruments in the edulcoration of oils; but as their action on putrid oils, and the method of applying them to this end, are not the same in both, it is proper to consider them distinctly.

Of alkaline salts it is the fixed kind only which are proper to be used for the edulcoration of oils. Fixed alkaline salts, in a dissolved state, being commixed with putrefying animal substances, appear to combine with the putrid matter, and, mixing with some of the principles, form instantly volatile alkaline salts. On the less putrid they seem to act, after their combination, by an acceleration of the putrescent action, till they attain the degree which produces volatile salts. This is evident by the sensible putrid ferment and smell which appear after their commixture; but which gradually abating, the oil is rendered sweeter, much lighter coloured, and thinner.

Their great use in the edulcoration of fish-oil arises therefore from their converting such parts of the gelatinous fluid and bile as are highly putrefied instantly into volatile salts, and causing a rapid putrefaction of the other parts; by which means the oil is freed from them by their dissipation. They

do not, however, equally act on the parts of the oil on which the empyreumatic ſcent depends, unleſs by the aſſiſtance of heat; for when they are commixed with the oils without heat, in proportion as the putrid ſmell diminiſhes, that becomes more ſenſibly prevalent. The ultimate action of lixiviate ſalts on animal oils, except with reſpect to the empyreuma, ſeems to be the ſame either with or without the medium of heat; for the ſame urinous and putrid ſmell, gradual diminution of the colour, and fœtid ſcent, happens in one caſe as in the other, except with regard to the acceleration of the changes; and ſuch ſalts, where the purification is required to be made in a great degree, are a neceſſary means, as they are more effectual than any other ſubſtance that can be employed.

The uſe of lixiviate ſalts alone is not, however, the moſt expedient method that can be purſued for the edulcoration of oils, for ſeveral reaſons. If they be uſed alone, cold, in the requiſite proportions, they coagulate a conſiderable part of the oil, which will not again ſeparate from them under a very great length of time; and when they have deſtroyed the putrid ſcent, a ſtrong bitter empyreumatic ſmell remains. The ſame inconvenience, with relation to the coagulation of part of the oil, reſults when they are uſed alone with heat. The ſuper-addition of common ſalt (which reſolves the coagulum and counteracts the ſaponaceous power of the lixiviate ſalt, by which the oil and water are made to combine) is therefore neceſſary; and the expenſe ariſing from the larger proportion of lixiviate ſalt requires it to be employed if no other alkali be taken in aid, and renders the junction of alkaline earths with it extremely proper in the edulcoration of oils for commercial uſes. Lime has alſo an edulcorative power on animal oils; but it has alſo ſo ſtrong a coagulative action, that the addition of a large proportion of alkaline ſalts becomes, when it is uſed, neceſſary to reduce the concreted oil to a fluid ſtate; and therefore this ſubſtance alone is not proper for that purpoſe. The combination of lixiviate ſalt with lime, or the ſolution commonly called ſoap-lye, has an effectual edulcorative action on fœtid oils; but it makes a troubleſome coagulation of part of the oil if no common ſalt be employed, and muſt be uſed in ſuch large proportion, if no alkaline earth be added, as renders the method too expenſive.

Lime has a power of combining with and abſorbing the putrid parts of the gelatinous fluid and bile when commixed with oil, and effects, either with or without heat, a conſiderable edulcoration of fœtid oils; but it combines ſo ſtrongly

with them, either cold or hot, that the ſeparation is difficult to be effected even with the addition of brine; and the oil, when a large proportion of it is uſed, can ſcarcely be at all brought from its concreted to a fluid ſtate but by an equivalent large proportion of lixiviate ſalt: the uſe of lime, therefore, alone is improper, or even in a great proportion with other ingredients. But when only a leſſer degree of edulcoration is required, a moderate quantity, conjoined with an equal or greater weight of chalk, which aſſiſts its ſeparation from the oil, may, on account of its great cheapneſs, be employed very advantageouſly: it will in this caſe admit of precipitation from the oil by the addition of brine. It may be alſo expediently uſed when lixiviate ſalt is employed with heat for the moſt perfect purification of oils; for it will in that caſe give room for the diminiſhing of the quantity of lixiviate ſalt, though the proportion be nevertheleſs ſo reſtrained as not to exceed what the proportion of lixiviate ſalt (juſt requiſite for the edulcoration) can ſeparate from the oil.

Chalk has an abſorbing power ſimilar to lime, but in a leſs degree, on the putrid ſubſtance of oil: it does not, however, combine ſo ſtrongly with the oil as to reſiſt ſeparation in the ſame manner, and is therefore very proper to be conjoined either with lixiviate ſalts or lime, as it renders a leſs quantity of either ſufficient, and indeed contributes to the ſeparation of the oil from them.

Magneſia alba, or the alkaline earth, which is the baſis of the ſal catharticus, and the ſingular earth which is the baſis of alum, both have an edulcorating power on fœtid oils, but, like lime, have too ſtrong an attraction with them to be ſeparated ſo as to admit of the reduction of the oil from the concreted ſtate to which they reduce it; and therefore, as they are not ſuperior in efficacy to lime and chalk, but much dearer or more difficult to be obtained, they may be rejected from the number of ingredients that are proper for the purifying of oils, with a view to commercial advantages.

Sea ſalt has an antiſeptic power on the mixed ſolid parts of animals; but uſed alone, or diſſolved in water, it does not appear to leſſen the putrid fœtor of oils, but, on the contrary, rather increaſes it. If after their commixture with it they are ſubjected to heat, it rather depraves than improves the oils; but though by its own immediate action on them it conduces ſo little to the edulcoration of oils, yet it is a medium for the ſeparation of water and the alkaline ſubſtances requiſite to be employed to that end. It is of great utility in the edulcorative proceſſes; for when alkaline ſalts or earths combine with the water neceſſary to their action on the oils,

or

or themselves form coagulums or corrections with it, a solution of salt will loosen the bond and dissolve the close union; so that the oil being separated will float on the aqueous fluid, while the earth, if any be in the mixture, will be precipitated and sink close together to the bottom of the containing vessel.

Sal catharticus, glauber salt, nitrum vitriolatum, tartar, and other neutral salts, though they counteract putrefaction in the mixed or solid parts of animals, seem to have little effect on oils with respect to their edulcoration, and cannot therefore be ranked amongst the substances proper to be used for that purpose.

Lead reduced to the state of a calx, either in the form of minium or litharge, has a strong edulcorative power on fœtid oils, and is indeed applied to that end, with respect to one kind of vegetable oil, for a very bad purpose, considering its malignant qualities on the human body.

In the case of train-oil, which will scarcely ever be considered among the esculent kinds in this country, the same objection against its use would not lie; and employed either with or without heat, it is a powerful absorbent both of the putrid and empyreumatic parts that occasiou the fœtor.

As, however, there may be some prejudice against its use even in any way, and as it is not absolutely necessary, I have not given it a place among the ingredients of the processes I recommend.

The ochrous earth of iron, commonly called red ochre, has an absorbing power on the putrid parts of oil, but combines so strongly that the separation is tedious even with the addition of brine: if, nevertheless, it is added when chalk and lime have been some time commixed with the oil, as in process the first, it will promote the edulcorative intention, and will subside along with them; and, as it has some advantage without increasing the expense, unless in the most inconsiderable degree, its use may be expediently admitted in that process.

Essential and ethereal oils are applicable to the prevention of putrefaction in the mixed and solid parts of vegetables, but are not so to the edulcoration of fœtid oils; and if they had the desired effect, they would not, on account of their price, answer the commercial end, unless the due effect was produced by adding them to the oils in a very small quantity.

The same holds good of spirits of wine as of essential and ethereal oils, both with respect to their efficacy and the expense.

Water has an edulcorative action on fœtid oils by carrying off the most putrid parts of the gelatinous fluid or bile, in which,

which, as was above explained, the principal fœtor resides, if the quantity added be large, and an intimate commixture be made of them by stirring them together for a considerable time: this only partially removing those heterogeneous putrescent substances, the remaining part soon acquires the same state, and the oil again grows fœtid, though not to the same degree as before.

Water is, however, a necessary medium for the action of salts and the separation of alkaline earths and calces of metals when they are employed for the edulcoration of oils, as will appear from a consideration of my processes.

Air edulcorates oil by carrying off the most putrid parts, which are necessarily extremely volatile. It may be made to act on them either by simple exposure of them to it with a large extent of surface, or by forcing it through them by means of ventilators, as has been practised by some dealers; but is now, I believe, neglected on account of their finding the improvement of oils by it not adequate to the trouble, as the gelatinous matter and bile, not reduced to a certain degree of putrefaction, being left behind, putrefy again to nearly the same degree as before.

It appears from these several observations, that the cheapest ingredients which can be used for the edulcoration of train-oils are lime and chalk, which may, with the addition of a proper quantity of solution of sea salt or brine, be made to procure a separation of them from the oils, according to process the first, so as to answer for some purposes; that the lixiviate salt is the most powerful purifier of oils, and, with the assistance of chalk and brine, will, without heat, according to process the second, effect a very considerable degree of edulcoration; and that lixiviate salt used with heat, with the addition of lime and chalk, to save a part of the quantity which would otherwise be necessary, and of brine to procure a quick separation, will perform an edulcoration sufficient for all commercial purposes, according to process the third; but that calcined lead and the ochrous earth of iron may, perhaps, be applied in some cases with advantage, where the oil is not designed for esculent use.

PROCESS THE FIRST.

For purifying Fish-Oil in a moderate Degree, and at a very little Expense.

Take an ounce of chalk in powder, and half an ounce of lime slaked by exposure to the air; put them into a gallon of stinking oil, and, having mixed them well together by

 stirring,

ſtirring, add half a pint of water, and mix that alſo with them by the ſame means. When they have ſtood an hour or two, repeat the ſtirring, and continue the ſame treatment at convenient intervals for two or three days; after which ſuperadd a pint and a half of water in which an ounce of ſalt is diſſolved, and mix them as the other ingredients, repeating the ſtirring, as before, for a day or two. Let the whole then ſtand at reſt, and the water will ſink below the oil, and the chalk ſubſide in it to the bottom of the veſſel. The oil will become clear, be of a lighter colour, and have conſiderably leſs ſmell, but will not be purified in a manner equal to what is effected by the other proceſſes below given; though, as this is done with the expenſe of only one ounce of ſalt, it may be practiſed advantageouſly for many purpoſes, eſpecially as a preparation for the next method, the operation of which will be thereby facilitated.

PROCESS THE SECOND.

To purify, to a great Degree, Fiſh-Oil without Heat.

Take a gallon of crude ſtinking oil, or rather ſuch as has been prepared as above mentioned, and add to it an ounce of powdered chalk; ſtir them well together ſeveral times, as in the preceding proceſs, and, after they have been mixed ſome hours, or a whole day, add an ounce of pearl-aſhes diſſolved in four ounces of water, and repeat the ſtirring as before. After they have been ſo treated for ſome hours, put in a pint of water in which two ounces of ſalt are diſſolved, and proceed as before: the oil and brine will ſeparate on ſtanding ſome days, and the oil will be greatly improved both in ſmell and colour. Where a greater purity is required, the quantity of pearl-aſhes muſt be increaſed, and the time before the addition of the ſalt and water prolonged.

If the ſame operation is repeated ſeveral times, diminiſhing each time the quantity of ingredients one-half, the oil may be brought to a very light colour, and rendered equally ſweet in ſmell with the common ſpermaceti oil.

By this proceſs the cod-oil may be made to burn; and, when it is ſo putrid as not to be fit for any uſe, either alone or mixed, it may be ſo corrected by the firſt part of the proceſs as to be equal to that commonly ſold: but where this proceſs is practiſed in the caſe of ſuch putrid oil, uſe half an ounce of chalk and half an ounce of lime.

PROCESS THE THIRD.

To purify Fiſh-Oil with the Aſſiſtance of Heat, where the greateſt Purity is required, and particularly for the Woollen Manufacture.

Take a gallon of crude ſtinking oil, and mix with it a quarter of an ounce of powdered chalk, a quarter of an ounce of lime ſlaked in the air, and half a pint of water; ſtir them together, and, when they have ſtood ſome hours, add a pint of water and two ounces of pearl-aſhes, and place them over a fire that will juſt keep them ſimmering, till the oil appears of a light amber colour, and has loſt all ſmell, except a hot, greaſy, ſoap-like ſcent. Then ſuperadd half a pint of water in which an ounce of ſalt has been diſſolved; and having boiled them half an hour, pour them into a proper veſſel, and let them ſtand till the ſeparation of the oil, water, and lime be made, as in the preceding proceſs. Where this operation is performed to prepare oil for the woollen manufacture, the ſalt may be omitted; but the ſeparation of the lime from the oil will be ſlower, and a longer boiling will be neceſſary.

If the oil be required yet more pure, treat it, after it is ſeparated from the water, &c. according to the ſecond proceſs, with an ounce of chalk, a quarter of an ounce of pearl-aſhes, and half an ounce of ſalt.

Obſervations on Proceſs the Firſt.

This proceſs may be performed on any kind of fiſh or ſeal-oil that is putrid and ſtinking, and will improve it in ſmell, and generally render the colour lighter, if previouſly dark and brown: it will alſo conduce to render theſe oils fitter for burning, which are, in their crude ſtate, faulty in that point; but it will not meliorate them to the full degree they admit of even without heat, and ſhould therefore be practiſed when only a moderate improvement is required.

Secondly, When the oil is taken off from the dregs and brine, the dregs which ſwim on the brine ſhould be taken off it alſo, and put into another veſſel of a deep form; and on ſtanding, particularly if freſh water be added and ſtirred with them, nearly the whole remaining part of the oil will ſeparate from the foulneſs; or, to ſave this trouble, the dregs, when taken off, may be put to any future quantity of oil that is to be edulcorated by this method, which will anſwer the ſame purpoſe.

Obſervations on Proceſs the Third.

Firſt, This is moſt advantageouſly performed on train-oil, called vicious whale-oil; and the more putrid and foul it may be, the greater will be the proportionable improvement, eſpecially if there be no mixture of the other kinds of fiſh-oils, particularly the ſeal, which do not admit of being edulcorated perfectly by means of heat, but require other methods: but when the vicious oil is pure from admixture of others, however ſtinking it may be, the bad ſmell will be removed by this proceſs duly executed, and the brown colour changed to a very light amber; and theſe qualities will be much more permanent in this than in any crude oil, as it will not, from the degree of purity to which it is brought, be ſubject to putrefy again under a great length of time, whether it be kept open or in cloſe veſſels.

The oil in this ſtate will burn away without leaving the leaſt remains of foulneſs in the lamp; and, being rendered more fluid than before, will go further, when uſed in the woollen manufacture, than any other kind, and will be much more eaſily ſcoured from the wool.

If, nevertheleſs, there be any branches of the woollen manufacture which require the uſe of a more thick and unctuous oil, this may be rendered ſo by the addition of a proper quantity of tallow or fat, of which a certain proportion will perfectly incorporate with the oil, the fluidity and tranſparency being ſtill preſerved, as well as all the other qualities that render it ſuitable to the intended purpoſe. This may be moſt beneficially done by adding a proper quantity of the refuſe greaſe of families, commonly called kitchen ſtuff, which being put to the oil, when moderately heated, will immediately diſſolve in it, and let fall alſo its impurities or foulneſs to the bottom of the veſſel, and render the purified admixture a conſiderable ſaving to the manufacturers.

Secondly, The different qualities and diſpoſitions of different parcels of vicious oil with reſpect to edulcoration render various proportions neceſſary of the ingredients to be uſed. The quantities ſtated in the above proceſs are the leaſt which will effect the end in general, and frequently greater will be required; but this may always be firſt tried: and if it be found, after ſix or eight hours ſimmering of the mixture, that no gradual improvement is making in the ſmell and colour, but that the oil continues the ſame in thoſe particulars, and remains alſo mixed with the chalk and lime, and in a thick turbid ſtate, a fourth or third part of the firſt quantity of pearl-aſhes ſhould be added, and the ſimmering continued

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till the oil be perfect. As the quantity of the water is lessened by the evaporation, it is necessary to make fresh additions from time to time, that there may be always nearly the original proportion.

Thirdly, If it be inconvenient to give the whole time of boiling at once, the fire may be suffered to go out and be rekindled at any distance of time; and if, in such case, a small proportion of pearl-ashes dissolved in water be added, and the mixture several times stirred betwixt the times of boiling, it will facilitate the operation. The time of boiling may be also much shortened, if the chalk, lime, and pearl-ashes, be added for some days before, and the mixture frequently stirred.

PROCESS THE FOURTH,

Which may be practised alone instead of Process the First, as it will edulcorate and purify Fish-Oil to a considerable Degree, so as to answer most Purposes, and for Process the Third, when the whole is performed.

Take a gallon of crude stinking oil, and put to it a pint of water poured off from two ounces of lime slaked in the air; let them stand together, and stir them up several times for the first twenty-four hours; then let them stand a day, and the lime-water will sink below the oil, which must be carefully separated from them. Take this oil, if not sufficiently purified for your purpose, and treat it as directed in Process the Third, diminishing the quantity of pearl-ashes to one ounce, and omitting the lime and chalk.

ROBERT DOSSIE*.

XXI. *On Painting.* By Mr. E. DAYES, *Painter.*

ESSAY IX.

On Style.

Nor, whilst I recommend the studying the art from artists, can I be supposed to mean that nature is to be neglected. *Sir Joshua Reynolds.*

PERFECTION in painting requires that the choice, the imitation and execution be directed to the same idea: this only can produce a perfect unity in the whole work. It will appear defective in proportion as it is deprived of a union of these qualities; as that which possesses the fewest

* The dregs remaining after the sundry processes above mentioned will form an excellent manure, as has been since noticed in Dr. Hunter's Georgical Essays.

faults will ever be the moſt perfect work. Hence the foundation of a rational inquiry after excellence in art; for he who wiſhes to examine a picture nicely or critically, muſt make himſelf acquainted with the firſt idea, or general intention of the whole, then of each part ſeparately, conſidering them in themſelves as relative to each other and to the whole.

An inquiry after the different ſtyles of painting would naturally lead to a hiſtory of the art itſelf; but as that is a ſubject that has been ſo frequently handled, we ſhall only touch ſo far on it as may immediately anſwer our purpoſe.

The ſo much boaſted criticiſms on the works of the antients, which are to be found in various authors, can be but little depended on, though often dreſſed up in the technical phraſes of art; becauſe the ſtrongeſt language will always be uſed on the moſt extraordinary occaſion, but the advantage reſulting to the reader will depend on the capacity of the writer.

All diſcuſſion at preſent on works that have ceaſed to exiſt for near 2000 years would be only loſs of time, as, from want of reference, they could not tend to illuſtrate any one rule of art. Such inquiries may ſerve to amuſe the idle, but will not tend in the leaſt to benefit the artiſt.

No one can deny, however humiliating the thought may be, that we are indebted to the Greeks for ſome of the fineſt forms at preſent in art. Many have attributed their ſuperior powers to the climate: but we ought rather to aſcribe them to the freedom they enjoyed, and the wiſdom of their legiſlators; not forgetting their enthuſiaſm for beauty, which they conſidered as a gift of the gods; and that with them men were more valued for their perſonal merit than for the wealth they poſſeſſed. The happy Grecian might ſit himſelf down contented in his poverty, knowing it was not thought diſreputable, and that his abilities would prove a ſufficient paſſport to ſociety and to the higheſt honours. The modern artiſt is ſolicitous of making money, knowing it is now the firſt teſt of his abilities in the opinion of the world, and a ſtronger recommendation than wiſdom. Hence the nobler energies of the ſoul are weakened; and from want of the ſtronger motive, honour, the love of fame ſinks into the baſe and ſelfiſh deſire of wealth. This has induced the weak and puſillanimous to apply to the arts; and as they aſpire after nothing but intereſt, they are unacquainted with thoſe ſublime conceptions the arts require.

The Phœnicians are believed not to have carried the arts to any great degree of perfection. To be ſufficiently well for the purpoſe of exportation would be the utmoſt that would

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be required; and perhaps their merchants would not be inclined to riſk much on articles the buyers of which would be the wealthy, and often the ignorant. What might be requiſite for the purpoſe of ornament would be more likely to be ſhowy than juſt.

The Romans appear to have encouraged the arts as a means of adding to their pride, and of feeding their vanity. As a people, they are rather to be viewed at a diſtance; their character is too ſelfiſh and oppreſſive to invite to an intimacy. The beſt works produced among the Romans from Auguſtus to Trajan are juſtly held to be of Grecian workmanſhip.

It is always more eaſy to imitate the ſtyle than the reaſonings and ſcience of the original: hence thoſe who ſucceeded the early Greeks failed by degrees in the moſt eſſential parts; which may account for that ſort of mechanical harſhneſs, and often want of elegance, obſervable in ſome of the works called Roman.

We have no right to look for true taſte among a people who could drag their captives at their chariot wheels, or ſlaughter them in theatres. They appear to have preferred pomp and ſhow, "barbaric pearl and gold," to true taſte; and exhibit a picture of gaudy and well-diſciplined barbarians. A nation which places the firſt reputation on arms or war, will never have a higher eſteem for the peaceable profeſſor of deſign than a Spartan or Roman. Many of their moſt renowned works are recommended more to notice on account of their richneſs than beauty, as Nero's golden palaces, &c. Pomp and luxury was their object; and they fell into the common error of ignorance, that of augmenting the matter inſtead of improving the form *.

Among the moderns, every country that has formed a ſchool appears to have had a cauſe for its ſtyle in its national character. The gravity of the Florentines and Romans might require that juſtneſs and truth of form which they ſaw in the antique ſtatues. The Venetians, a wealthy and gay people, would delight in magnificence from their commerce with the Eaſt; and painting for the rich and luxurious would neceſſarily introduce ſplendour and brilliancy of colour, with proceſſions, feaſts, &c. The Flemiſh and Dutch were content with ſuperficial or general repreſentations of things. Of the French, the beſt maſters have ſought perfection in the Roman ſchool; while others, complying with the national love for ſplendour, have ſought perfection by buſtle and ſhow. Of our own nation, the love of locality and portraiture may be

* In point of order, the Phœnicians ſhould precede the Grecians; but I have paid no attention to chronological arrangement.

ſaid ſtrongly to mark the *amor patriæ,* and to exhibit their charity and love for each other.

A knowledge of the different ſtyles is abſolutely neceſſary to enable us to think deeply and freely. No man, however great his powers, was ever capable of ſubſiſting on his own ſtock: the more wide the field of inquiry, the more we increaſe our knowledge, and quicken and enlarge our ideas. We cannot doubt that M. Angelo and Raphael poſſeſſed all the knowledge of art diſcovered in their time. 'Tis our duty to live, as it were, amidſt the great works of art, that, by enriching our minds, we may be able to produce ſomething great and noble of our own. This is the true ſpirit of imitation, and which we may continue, without fear of its doing us an injury, from infancy till we arrive at the fulleſt ſtate of vigour.

By ſtyle as well as manner we are enabled to judge if a picture be the work of a certain maſter; for, ſhould we remain doubtful from the former, a reference to the penciling may determine the point. For, as in writing or ſpeaking we ſhall generally diſcover in perſons a fondneſs for certain phraſes, or a peculiar turn or connection of their ſentences, by which their ſtyle may be known: ſo in painting we ſhall diſcover ſome favourite part forced on the eye; or thought, attitude, or habit occur, which ſtamps the maſter's ſtyle. Every one will poſſeſs more or leſs of the ſtyle and manner of the maſter or ſchool from which he comes. Raphael, in his oil pictures, never wholly got rid of that littleneſs of ſtyle derived from Perugino.

To inſure a good ſtyle we muſt early habituate ourſelves to contemplate noble works of imagination. This, if connected with a vigorous mind, a lively fancy, a ſtrong memory, and good judgment, will be attended with ſucceſs. That thoſe qualities are neceſſary to enable us to form a good ſtyle, is certain; for by the imagination we conceive images, and if the impreſſions be clear the ſtyle will be ſo too. But ſhould the images be faint and imperfect, the ſtyle will partake of theſe defects. For it cannot be denied that, as the painter is affected himſelf, in the ſame degree will he move the ſpectator. Hence, if the mind be dull, and indiſpoſed to receive clear and diſtinct ideas of things, the ſtyle will be ſtiff and heavy; or, if the images be irregular and diſordered, the work will be perplexed and confuſed. It appears to follow of courſe, that a lively fancy will be accompanied with a happy memory: through this we are ſupplied with the vaſt treaſures of art and nature; for without a large ſtock of images we ſhall never be able to diverſify our works in the way variety

riety demands, and they would appear infipid from the too frequent return of the fame ideas. But, unlefs all this be accompanied by a good judgment, the imagination will riot at the expenfe of reafon, and we fhall never poffefs a found and accurate ftyle. Hence it is that we often confound genius with an active imagination, not recollecting that excefs is not its character, and that the more we crowd with incidents the more we weaken; and that, like great talkers, we may be bad orators.

We fhall now proceed to defcribe, in the beft way we can, the characters of the various ftyles. Tafte and ftyle differ from each other; the former applying to our choice of objects, while the latter appears to arife from our mode of treating them, or the augmenting certain parts and depreffing others, as in the figures of M. Angelo, in which we fee the convex lines raifed fo much as to give them a mufcular and gigantic air; by attempting which many of his imitators have often loft the effential character of the object. We fay "the great ftyle of Raphael's drapery," not merely on account of the cafting of the folds, which fhows *tafte*, but from his dropping the minute parts, and taking only thofe effential to the great character in painting. The artifts who have fought the great ftyle have purfued the above conduct; that is, have attended to the great and effential character, while thofe who have forced the trifling parts on the eye have formed a mean or little one. The great ftyle requires the human face, the other includes the wrinkles and other marks of the infirmities of nature.

Sublime Style.

The fublime ftyle is by many connected with a certain degree of intemperance and excefs. The attempts of fuch may juftly be termed the hobgoblin ftyle; for with them nothing is fublime but what will fcare a man out of his fenfes. But fcenes terrible or fhocking, however admiffible in poetry, or where an orator may have occafion to work on the feelings of his audience, do not affociate happily with painting; and, when attempted without the greateft care and circumfpection, become either ridiculous or difgufting. Brueghel (called hellifh), as alfo Callot, in their whimfical fcenes intended to affect us ferioufly. And Rubens, out of the number of reprefentations he has left of the fall of the damned, has rather fhown a warmth of imagination than judgment in their treatment: it is true, the machinery he had to ufe was human figures; but inftead of making the moft of them by exhibiting their fufferings, and thereby apply-

ing to our feelings, he has created a ſet of fiends that make us laugh. Scenes of horror require great delicacy of treatment, as the mind cannot dwell without diſguſt on repreſentations brought home in that determined way which painting demands. Pilkington relates, from Sandrart, that Spagnoletto repreſented an Ixion on the wheel ſo full of pain and agony, that the wife of Mr. Uffel, the poſſeſſor, from looking on it when with child, was ſo affected by it, "that her child when it was born had all the fingers diſtorted exactly as the fingers of the Ixion appeared in the picture." So ſenſible of the neceſſity of this delicacy have the beſt painters been, that they have concealed as much as poſſible the ſhocking parts of a ſpectacle. In the Slaughter of the Innocents, Pouſſin would be content with an incident or two, while Le Brun in the ſame ſubject has aggravated all the horrors by an endleſs variety of butcheries. Rubens, in one of the fineſt ſketches of his we have had in this country, has repreſented, in a diſguſting way, a ſaint with his hands and feet cut off; and has moſt injudiciouſly, nay, moſt inſenſibly and indelicately, introduced dogs licking up the blood. Contraſt the above and Titian's picture of the winding out a ſaint's bowels on a wheel, with Domenichino's delicate and ſenſible repreſentation of the death of St. Cecilia. A Britiſh artiſt would diſplay more feeling and delicacy in repreſenting a bull-bait, than either Titian or Rubens have done in the above compoſitions. Juſtice muſt allow that a want of delicacy is not often chargeable on the Italians.

In the ſmall compaſs we have been obliged to preſcribe to ourſelves, we fear it will become difficult ſufficiently to compreſs the matter, and at the ſame time render the ſubject tolerably clear.

We take it for granted that the mind well informed is the true ſtandard of whatever is great and illuſtrious in any point of view. Hence it will follow that in works of imagination we ſhall derive credit in proportion as we diſplay more or leſs mental energy. For though we may not poſſeſs the power of colouring, or ſuch other excellences as would captivate the eye, yet we may exert the vigour of the ſoul in the reaſoning and ſcience of the work; and this energy it is in our power to improve by education and habit. One of our firſt duties is to enlarge and elevate our notions; for the dignity and grandeur of our work depend entirely on the dignity and grandeur of our thoughts, and the elevation of the ſoul. A greater misfortune cannot attend the arts than for men of mean parts to practiſe them, either as painters or engravers, as they invariably communicate the ſame bad qualities to their

their works. We may look below the ſuperficies, and not be dazzled with a gaudy appearance, or ſuffer our admiration to dwell on what the wiſe would contemn; or we may be led away after pageantry and pomp, miſtaking them for true honour and glory. By exerting the mind we may raiſe our work into the ſublime, from a judicious introduction of ſuch acceſſory circumſtances as may add dignity or contribute to the illuſtration of the ſtory; particularly if they have a ſkilful connection, and affect the imagination. We have noticed ſome ſuch inſtances already in our Eſſay on Invention, as in Raphael's Paul at Lyſtra, Barry's picture of Elyſium, &c. Theſe acceſſory circumſtances occur frequently in the works of the poets, and contribute much to heighten the ſcene; as in Lear, the thunder ſtorm makes the heart bleed for the ſufferings of the old king; and how ſublime does the viſion of the dagger render Macbeth by its judicious introduction! Vaſtneſs is productive of the ſublime, by conſidering any object that takes up much room in the fancy. But we muſt be careful not to fall into a common error, and miſtake greatneſs of bulk for nobleneſs in works of art: one of Lyſippus's ſtatues of Alexander, though no bigger than the life, might give the mind more noble ideas than Mount Athos had it been cut into the figure of that hero. This ſubject has been in ſome meaſure amplified already in our Eſſays on Invention and Compoſition: it may therefore be ſcarcely neceſſary to mention, that the ſublime requires that the ſubject of our picture ſhould be a great one, and, if poſſible, carry with it a univerſal intereſt. In the compoſition, ſimplicity and gravity are eſſential to produce grandeur: we cannot wiſh for better examples than are offered to our view in the Cartoons of Raphael; particularly the Paul at Lyſtra, his Preaching at Athens, and in the Death of Ananias. We ſhall obſerve great grandeur in thoſe fine compoſitions by Weſt, of the Departure of Regulus, Mark Antony haranguing over the body of J. Cæſar, and the Swearing young Hannibal: the Death of Stephen by the ſame artiſt is full of the pathetic: the prints from the above are in every one's hands. Too much contraſt deſtroys the great ſtyle; it aſſociates beſt with the pleaſing. Beauty excites gaiety and pleaſure, the ſublime inclines to ſerioufneſs. Elevation of character is alſo neceſſary; a want of nobleneſs contributes much to depreciate the works of the Flemiſh, and particularly of the Dutch ſchool. The Hercules and the Apollo Belvidere in their form approximate moſt to the ſublime, except we be permitted to conjecture what might have been the famous Jove and Minerva of Phidias. A broad light and ſhade, or, in other words, a

fine *chiaro-ſcuro*, add an effect of ſublimity. Some of Rubens's pictures ſtrike wonderfully on that account, and Reynolds's Infant Hercules receives an uncommon air of grandeur from the broad and judicious diſpoſition of the maſſes. Though this ſtyle does not require the ſoft harmonious glow of Venetian colouring, which agrees beſt with the beautiful, yet it by no means follows, that it authorizes a diſregard of the grouping of the colours, to the total neglect of the general harmony of the picture. The colouring ſhould be ſober and dignified; we do not mean black and heavy, but compoſed of ſuch colours as are full, rich, glowing, and rather deep than light. The penciling ſhould be firm and deciſive, with the parts well defined. We ſhould particularly guard againſt trifling events, poor or mean thoughts, and whatever is low and vulgar: ſuch things mar a good whole, and appear worſe by contraſt, like the blemiſhes on beautiful bodies. The moſt eſteemed maſters have carefully avoided introducing in their works things ſordid and baſe: in the higher ſtyle there ſhould never appear any thing inſignificant or unneceſſary, as dogs, cats, parrots, &c.: ſuch things as theſe often add a grace to the pictureſque, but deſtroy grandeur. Neither will theatrical ſplendour or gaudy apparel ſuit the ſublime: the reaſon is, they affect not beyond the eye; and that which leaves no impreſſion on the mind, we may reſt aſſured, is not the thing we ſeek. A work truly ſublime does not merely pleaſe: that is the province of inferior excellence. A grand work will confound, aſtoniſh, and, with the impetuoſity of a hurricane, bear down all before it. The ſublime appears founded on a union of the moſt noble and elevated parts of nature joined to the moſt profound efforts of the imagination. Its qualities appear to be ſimplicity, with a certain uniformity united with ſolemnity and gravity. Simplicity is neceſſary to nobleneſs, as ornament deſtroys greatneſs of manner. So the parts ſhould be ample, as is effected by large mantles, &c.

> At Agis' ſummons, with a mantle broad
> His mighty limbs Leonidas unfolds,
> And quits his couch. GLOVER.

M. Angelo and Raphael approach this ſtyle in their ideas and inventions, but neither appears to accord with it in his forms. M. Angelo, from attempting the ſublime, produced what may be termed the *terrible*, in which the attitudes are forced and extraordinary, and the figures vaſt, robuſt, and muſcular: he choſe in expreſſion the point moſt extreme, and generally departing from objects in themſelves pleaſing.

Expreſſive

Expressive Style.

In this Raphael stands a shining example, and appears to have touched the extreme point of excellence. Happily we have many of his finest works at hand in the Cartoons at Windsor Castle. Witness his Elymas the sorcerer, whose figure is most justly expressive of the punishment of blindness which had befallen him; and the astonishment of the spectators is depicted with great judgment. But let us contrast the above with the Death of Ananias, and observe the consternation and terror in the spectators at a punishment so much more terrible. There we behold with what a masterly hand the artist has raised the feelings in proportion to the exciting cause, without the least waste of force in the expression. In the first picture is more repose; in the second, a greater degree of action corresponding with the interest excited by the event. In the first picture we see the surprise of an earthly judge at an event beyond the power of his understanding; in the other, a calm and dignified set of beings, conscious of the interposition of a Divine Power. Much has been said of the Cartoons; every one speaks of the dignity of the Paul in the picture representing his "preaching at Athens," which for simplicity and dignity reaches the sublime. History is the walk that ennobles the art. This calls forth exertions that elevate and dignify our nature. It might be doubted if the Greek ever arrived to that degree of perfection in expression which Raphael has shown in his works: they certainly sacrificed it to the beauty of appearance. Still we shall look with delight on the Laocoon, the dying Alexander, the Niobes, &c. Raphael, to assist the expression in his figures, appears to have marked the tendons; those who have sought beauty have attended more to the fleshy parts of the muscles. His style of drapery is simply grand, in the extreme of perfection, and well worthy of being studied. Even Poussin, who is said to excel in it, is in his best works inferior. Raphael is more judicious and select; Poussin more natural. Justice must allow that the former took the hint for this great style of drapery from M. Angelo. Raphael sometimes reached the graceful, and but seldom the beautiful, and never exquisitely. We have selected the works of the above artist, esteeming them the first for expression; but we shall find admirable traits of the same kind in those of the Caracci, Domenichino, Poussin, &c. Some who have attempted the expressive style, imagining the whole merit lay in excess and violence, have writhed their figures into convulsions, when the occasion would not require more exertion than

than would be neceſſary to take a pinch of ſnuff or raiſe a ſtraw; nay, they will not let them even ſleep in peace. Such bombaſtic ſtuff may amuſe the weak, as faſhion in art will pleaſe for a time even at the expenſe of truth; but the triumph will be tranſitory as a ſun-beam on a winter's day.

Beautiful Style

Requires that the objects be elegant, void of ſuperfluity, and ſoft in the execution. Perhaps the truly beautiful ſtyle muſt be ſought in the works of the antients. The Apollo Belvidere approaches the ſublime, and forms, of its kind, a point of perfection: ſome of the Niobes exhibit exquiſite female beauty, but in the Venus de Medicis and Apollo we ſee it united with grace. It is certain that in the antique ſtatues we muſt ſeek the beauty of ſymmetry, and that we cannot ſtudy them too often to fix the impreſſion of their excellencies on our minds; for it is next to impoſſible but that every reconſideration muſt unfold new beauties. The true mode of ſtudy is to impreſs their beauties ſo ſtrongly on the imagination as never to be forgotten, and not to ſtand in need of their preſence as a pattern. Boys are too often put to draw after the living model before they have imbibed a proper notion of, or reliſh for, beautiful proportion. There is no danger of ſuch ſtudies injuring, as we are ſurrounded by fine examples in *chiaro-ſcuro* and colour; and of the two, deciſion is more commendable than that ſlovenly manner which preſents the mere idea of a thing like a dream: the former diſplays knowledge, the latter ignorance. There is great difference in painting, between taking the ideas of natural things without giving them form, and that determined method ariſing from a poſitive knowledge. Guido's heads are beautiful; but his choice was often injudicious, many of his objects requiring ſtrong expreſſion, which he loſt for fear of deſtroying beauty. Albano's females are delicately beautiful; and we are ſurrounded by beauty in the portraits of Reynolds and others.

Graceful Style.

To form this ſtyle the motions of the figures ſhould be moderate, eaſy, agreeable, and unaccompanied by violence *. The antique ſtatues will aſſuredly afford the moſt perfect examples, becauſe, on a compariſon with the antients, the moderns appear to have become a little affected, and too often to have ſought grace in difficult attitudes, with forced and conceited turns in their figures. There are few of the Greek

* See the Eſſays on Grace and Beauty.

ſtatues

ſtatues in which grace does not abound; for, as they ſought beauty in their works, they cultivated grace as its inſeparable companion. Very graceful are the Apollo and the Venus de Medicis; ſo are the Meleager and Hermaphrodite. The Hercules is alſo truly graceful and eaſy, as is the Antinoüs, &c. Raphael underſtood the grace of motion; but he had it leſs in the contours of his figures; and his dry manner of execution contributed much to deſtroy beauty. Corregio appears the moſt perfect modern, Parmegiano being ſometimes too forced, and bordering on affectation. Reynolds's female portraits appear to have been touched by the Graces themſelves. Among the works of our ſculptors, the females of Nollekens poſſeſs ſuch a combination of grace and beauty as the Greeks might have acknowledged for their own without a bluſh.

Florid Style.

This ſtyle muſt be ſought amongſt the Venetians, alſo in Rubens, and thoſe Flemings who have followed him. Thoſe who have practiſed it have been content to pleaſe the eye by a brilliant diſplay of colour, contraſt in their groups, and oppoſition in light and ſhade. They appear to have admitted every deſcription of objects in their picture, provided they contributed to the buſtle or pleaſure of the whole. If this is not the moſt juſt ſtyle, experience teaches every one that it is the moſt popular, and perhaps we may add the moſt profitable.

The above maſters muſt not be confounded with thoſe who have practiſed a ſtyle ſufficiently eaſy, but who have been content with giving ſuch an idea of a thing in their works as would ſerve to diſtinguiſh one from another without regarding their perfection. At the head of this latter claſs ſtand P. Cortona and L. Giordano.

Natural Style.

This ſtyle is called natural, from the artiſts practiſing it wanting the power to improve on the original, or of chooſing the beſt of the kind. It is to be ſeen in the Dutch ſchool in the works of Rembrandt, G. Dow, Meris, young Teniers, &c. This ſchool has improved the aërial perſpective, and poſſeſſes great excellence of colour and *chiaro-ſcuro*, to which it has joined great truth, as far as a ſimple repreſentation would permit. It has excelled in what may be termed the mechanical part of the art; and thoſe who wiſh to ſeek after an elegant power of penciling will be highly gratified in the admirable works of Teniers, Cuyp, Berghem, &c. &c.

As each of the above ſtyles has its peculiar beauties, we

muſt

must cautiously guard against falling into the opposite extreme. For the sublime is nearly allied to the extravagant; the expressive may be easily rendered bombastic or pedantic; and the beautiful, smirking or coquettish. The graceful, with the ignorant, may easily become the affected: perhaps there is but a slight partition between that affectation of grace in the works of Watteau, Bouché, and Le Moine, and the pure representations of Corregio, or those of Parmegiano. The florid may be mistaken for the showy and tawdry. This is most likely to happen from a cold lifeless imitation.

Works of genius are ever the result of feeling, to which we must be directed by spirit and judgment. A painter, a poet, or player, that imitates closely, will never excel. To be tamely alive in our works is not enough; spirit, vivacity, and vigour, are required. Whatever comes short of this is but one remove from imbecility.

XXII. *Memoir on the comparative Anatomy of the Electric Organs of the* Torpedo, *the* Gymnotus electricus *and the* Silurus electricus. *By* E. Geoffroy *.

SINCE philosophers have applied with so much success to researches respecting the Galvanic phænomena, it is of more importance than ever that a correct description should be given of the particular organs of certain fishes which are found to possess electric properties.

Analogy gives us reason to believe, that beings which possess faculties so extraordinary are indebted for them to an organization almost entirely similar; consequently, that these beings approach very near to each other, or rather, that they form only one family. But by the examination we are enabled to make, this is not observed to be the case: on the contrary, we are surprised to find that the electric fishes belong to genera exceedingly different, and that they are placed in these genera without violating in any manner the order of natural relations. An electric species, therefore, is known in each of the genera, of ray, tetrodon, trichiurus, gymnotus, and silurus.

To account for the great dissimilarity of the fishes which are distinguished from others of the same genera by the presence of electric organs, we must admit that the latter are not essentially connected with organs of the first importance, and that they belong at most to the common integuments,

* From *Annales du Museum National*, No. 5.

which

which vary in each ſpecies without producing any remarkable modification in the reſt of the organization.

This, however, is a reſult to which our ſtate of knowledge in regard to thoſe electric organs hitherto obſerved, does not ſeem to conduct; for, if we adopt the opinion of moſt anatomiſts, it will be found that the electric organ in the torpedo is very extenſive, exceedingly complex, and particularly remarkable in this reſpect, that nothing analogous to it has ever been obſerved. The Italian ſchool, at the head of which were Redi and his pupil Lorenzini, for a long time conſidered the numerous tubes of which that organ is formed as ſo many peculiar ſmall muſcles, *muſculi falcati*; and this opinion was generally adopted till the late John Hunter publiſhed his excellent Anatomical Deſcription of the Torpedo.

During my travels I have alſo had an opportunity of ſeeing torpedoes, and I ſoon diſtinguiſhed the electric batteries with which they are abundantly furniſhed. As it was by touching theſe kinds of apparatus that I experienced the ſtrongeſt ſhocks, and as the other rays exhibited nothing of the ſame kind, I entertained no doubt that I had before my eyes thoſe organs by means of which the torpedo renders itſelf ſo formidable in the boſom of the water, and can at pleaſure ſtrike with numbneſs thoſe animals which it wiſhes to make its prey. But at that time I was ignorant whether others before me had examined this organization; and, in that caſe, what addition to the obſervations already made it would be neceſſary for me to make. Being ſhut up in Alexandria during the time of the ſiege, and deprived of the uſe of my library, I conſoled myſelf for not being immediately able to clear up my doubts, by entertaining a hope that theſe organs were not known, at leaſt in regard to their relation with general phyſiology. To obtain that knowledge I endeavoured to find ſomething analogous in the other rays, being perſuaded that it was not ſo much the preſence of this organ, as a diſpoſition peculiar to it, that gave the torpedoes alone of all the rays the aſtoniſhing faculty of fulminating, as we may ſay, the ſmall inhabitants of the ſea. Thoſe who have compared only a few animals muſt know that few new organs are found among them, and particularly in ſpecies which reſemble each other ſo much as the rays. It was natural therefore to believe, that the tubes containing a gelatinous ſubſtance in the torpedo exiſted in a ſtate of concealment in the other rays; and it will here be ſeen that I indeed found in the latter an analogous organization, with differences to which we muſt refer the different modes of exiſtence and action of each ſpecies.

Rays,

Rays, as is well known, are flat fish, the pectoral fin of which is prolonged anteriorly on the sides of the head by means of a cartilage that borders its circumference. The torpedo differs from other fishes of the same genus by a very considerable interval between this cartilage and the head. All this large vacuity is filled up by prisms of six, five, and sometimes four planes. These prisms adhere by their bases to the skin above and to that below. They are arranged parallel to each other, follow the projecting and irregular contours of the head and branchiæ, and externally form a semi-elliptic stratum. When the skin is removed, all these prisms, the bases of which are then observed, exhibit the appearance of a honey-comb. They are so many small tubes filled with a substance which by chemical analysis I found to be a compound of gelatin and albumen. The texture of these tubes is aponeurotic, and they are united to each other by a kind of lax reticulation formed of tendinous fibres which envelop them in every direction: in the last place, they are covered and shut by an aponeurotic membrane, and above these coverings the skin is applied. This apparatus is furnished with nerves remarkable for their large size. There are distinguished four principal trunks, which are distributed to all the tubes, and which at length penetrate into their substance and expand in it.

Though rays, in which the cartilage of the pectoral fin immediately borders the contours of the head, were not, like the torpedo, in a condition to exhibit prisms or vertical tubes, they did not differ from them so much as might be expected. In the rays, as well as in the torpedoes, there issues from the cranium, a little before the ear, a nerve so large that it surpasses the volume of that which proceeds to the eye. This nerve proceeds laterally, creeps over the superior face of the masseter, and expands below, between that muscle and the first branchia, in a mass which on the first view might be taken for a gland, but which is really the focus from which proceed, in several bundles, a great number of tubes analogous to those of the torpedo. A bundle proceeds towards the nose, another spreads over the belly, a third ascends on the masseter and terminates behind the occiput, and a fourth extends over the muscles of the pectoral fin. In this respect there are some differences according to the species: but these tubes, in the ray as well as in the torpedo, always adhere to the skin above and to that below; only, instead of being vertical, which is impossible, for want of room, they follow the contour of the head, extend over the most exterior muscles, and are longer according as they have a larger circuit to

make

make before they are inserted in the skin. These long tubes seem to be of the same nature as those of the torpedo, and contain a gelatinous and albuminous substance entirely similar. Hitherto we observe in this respect no other differences between the common rays and the torpedo, except that the tubes in the latter are very short, vertical, close to each other, and parallel; while in the other rays they are much longer, bend around the principal muscles of the electric machines, and divide into several bundles formed of divergent radii.

But if these organs do not vary in each species but by a different arrangement of parts, is it not to be apprehended that we may fall into a consequence contrary to the facts observed, and ought we not to suppose that all rays are more or less endowed with the electric properties of the torpedo? Such, indeed, would be the opinion which we ought to form, if these organs were not distinguished by a character on which depend, in part, the astonishing properties of the torpedo. The tubes in the common rays open on the outside of the skin by orifices peculiar to them, and are so many excretory organs of the gelatinous matter which they contain. In the torpedo all these tubes are completely shut, not only by the skin, which has no perforations, but also by aponeuroses which extend over the whole surface of the electric organ. As the gelatinous matter cannot then escape, it is forced to be accumulated in these tubes: hence, no doubt, the greatness of their diameter, and on this account also their number increases at the different periods of life. Valst and Hunter, indeed, found this progressive augmentation. They counted more than two hundred of these tubes in young subjects, from four to five hundred in adult torpedoes, and even twelve hundred in an individual of a large size.

It is to John Hunter, as already said, that we are indebted for the best description of the electric organs of the torpedo*. Monro, in his Physiology of Fishes, has also described the corresponding apparatus found in the other rays; but I flatter myself that I am the first who compared these organs, who proved their identity, and reduced them to the same system of organization. The electric organ of the torpedo is really an organ of touching, furnished with an apparatus as extensive as that of seeing or smelling. The nerves which proceed thither are so large that their volume appeared to Hunter as extraordinary as the phænomena to which they give rise. They suddenly expand in a gelatinous mucus, and nothing impedes their free communication with external bodies.

* Philosophical Transactions 1773, p. 481.

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There can be no doubt that they perform a very confiderable part in the electric phænomena. Hunter was of opinion that they are destined to form, collect, and direct the nervous fluid. Their influence however is proved, fince it is known that the concurrence of the will of the animal is indifpenfably neceffary for giving fhocks. This evidently refults from the obfervations of M. Valft, and from thofe which I had occafion to repeat myfelf.

However, fince thefe nerves are found in other rays distributed nearly in the fame manner as in the torpedo, it muft be allowed that they are not alone fufficient for the production of electricity, and that for this purpofe they muft alfo be in a certain relation with the furrounding parts. Do the apertures of the tubes in the rays favour the iffue of the nervous fluid? Or, as in the torpedo, do the nerves require a larger quantity of gelatinous fubftance to enable them to expand in numerous rami, and to become proper for acting with more energy?

In order that we may afcertain how far thefe conjectures may be founded in truth, let us compare the electric organs of the torpedo, thofe defcribed by Hunter in the *gymnotus electricus*, and thofe which I difcovered in the *filurus electricus*. Thefe two fifhes are fo different from the torpedo, that they afford reafon to hope that this comparifon will throw confiderable light on the prefent queftion.

The gymnotus belongs to that order of fifhes diftinguifhed by the name of *apoda*: it is the genus which approaches neareft to that of the murenæ and eels; confequently they have a very long body, almoft cylindric, and fimilar to that of ferpents. Separated from the murenæ becaufe they have no fins on the back or tail, they are diftinguifhed from them alfo by the great fhortnefs of the abdomen. The anus, indeed, is fo near the head that it opens before the pectoral fins. But, on the other hand, the gymnoti have the tail of a moft extraordinary length: it is an organ to which all the reft feem to have been facrificed, and it is rendered lighter by a difpofition peculiar to this kind of fifh. The air-bladder, inftead of being inclofed in the abdominal cavity, extends to the infide of the tail, and is continued to its extremity. It is above this bladder that there is found in the gymnotus electricus a very fingular apparatus ftill more aftonifhing by its enormous fize than by its ftructure; an apparatus of which there is no veftige in the other fpecies of this genus, and which may be eafily known to be the electric organ of the gymnotus.

This organ is formed by the union of a very great number of

of aponeuroses, which extend in the direction of the length of the fish, forming so many horizontal strata, parallel, and distant from each other about a millimetre: other vertical laminæ, of the same nature, and much more numerous, intersect them almost at right angles; which produces a large profound reticulation composed of numerous cells of rhomboidal planes. The interior of these cells is filled with an unctuous substance of a gelatinous appearance.

The electric batteries are divided into four distinct masses, two of which are large and two small. Hunter gives to each pair the name of large and small electric organs.

The large organs are situated immediately below the air-bladder and the vertebral muscles. They are of such a thickness that they form alone more than half the volume of the tail. They are divided by a broad partition, which furnishes them with points, to which they are strongly attached. They adhere superiorly to the air-bladder, and to the muscles which accompany it, by a very compact cellular tissue, and they terminate inferiorly in a round edge towards the origin of the osseous pieces which support the radii of the fin of the anus.

The small organs occupy the lower region of the tail. They begin and end nearly at the same points as the large organs; are situated below them, and on each side of the osseous supporters of the anal fin: their general form is that of two long triangular pyramids. The two lateral faces of these pyramids are covered by muscular fibres, the aggregate of which produces the different motions of the fin. In this respect these small organs differ essentially from the large ones which are attached immediately to the skin, and which, having a more intimate connection with external bodies, are capable of producing more energetic effects.

The horizontal laminæ of the small organs, instead of being parallel throughout their whole length, are undulated at intervals. Hunter counted 24 in a large organ, and 14 in a small one. The laminæ which intersect the latter at right angles are far more numerous: they are so thin, and so near each other, that 240 are found in the extent of 9 inches.

This apparatus of electric organs is put in play by a system of nerves furnished by the spinal marrow, and distributed with admirable mechanism. Above the vertebral column is found a large nerve, which proceeds in a straight line from the cranium to the extremity of the tail; but though larger, and nearer the vertebral column, in the gymnotus electricus than in other fishes of the eel kind, it gives out only a few rami, which proceed to the electric organs. On the other hand, however, there issues from each vertebra a nerve, which not

only diſtributes branches to the muſcles of the tail, but ſends ſome alſo to the electric organs. The different rami of this nerve creep firſt over the ſurfaces of theſe organs, and ſpread and expand in their alveoli. It is thus that the vertebral nerves, by means of this deviation from their uſual route, and of an augmentation of volume, become in the gymnotus electricus ſo many inſtruments capable of ſtriking with death, or at leaſt with torpor, all thoſe animals which they touch.

The electric organ of this fiſh being placed under the tail, and in a part which conſequently is removed from the principal ſyſtems of life, it was difficult to conceive what were the nerves which could proceed thither. The ſimpleſt combination was to deduce them immediately from the ſpinal marrow; and this, indeed, is that which we ſee realized in the gymnotus electricus.

The ſimplicity of the means employed by nature is obſerved in a manner ſtill more particular in the ſilurus electricus. This fiſh differs almoſt as much from the gymnoti as from the rays, and therefore we muſt expect a quite different organization.

It is, indeed, neither on the ſides of the head, as in the torpedo, nor below the tail, as in the ſpecies we have deſcribed, that the electric organ of the ſilurus electricus is found. It is extended all round the animal; it exiſts immediately below the ſkin, and is formed by a conſiderable collection of cellular tiſſue, ſo thick and compact, that on the firſt view it might be taken for a ſtratum of lard: but when cloſely inſpected it is obſerved that this organ is compoſed of real tendinous or aponeurotic fibres interwoven with each other, and which by their different croſſings form a reticulation the meſhes of which are not diſtinctly viſible without the help of a magnifying glaſs. The ſmall cells or alveoli of this reticulation are filled with an albumino-gelatinous matter. They are prevented from communicating in the inſide by a very ſtrong aponeuroſis, which extends over the whole electric reticulation, and which adheres to it ſo cloſely that it cannot be ſeparated without tearing it. This aponeuroſis in other reſpects adheres to the muſcles only by a thin cellular tiſſue of little conſiſtence.

The nervous ſyſtem, which completes this electric organ, has no more relation with the nervous branches which we examined in the torpedo and the gymnotus than the tubes of the latter have with the peculiar covering of the ſilurus electricus. Theſe nerves proceed from the brain; they are the ſame as thoſe which my friend Cuvier has obſerved in all fiſhes to proceed under the lateral line: but theſe two nerves

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of the eighth pair in the silurus electricus have a direction and volume which are peculiar to that species: they descend, approaching each other on their issuing from the cranium towards the body of the first vertebra, which they traverse. They first introduce themselves through an orifice peculiar to each of them, and then issue on the opposite side by one aperture: after reascending they suddenly separate, and proceed under each of the lateral lines. They are then found lodged between the abdominal muscles and the general aponeurosis which extends over the electric reticulation. In the last place, they penetrate beneath the skin by means of large branches, which proceed to the right and left of the principal nerve. These branches are in number 12 or 15 on each side; they pierce the aponeurosis which lines the interior surface of the reticular tissue, penetrate to the centre of the reticulation, and at last expand in it.

The examination of the three electric organs, which I have compared with each other, necessarily conducts us to some interesting results respecting the kind of modification which organs common to all fishes ought to undergo to develop in some species electric properties. We find, 1st, That the part where the electric batteries are lodged is a matter of indifference, as they are diffused all around the silurus electricus, collected in the tail of the gymnotus, and united on the sides of the head in the torpedo. 2d, That no branch of the nervous system is particularly set apart for these organs, since the nerves distributed thither are all different. 3d, That the form of the cells is also of little importance, as this form varies in each species; but in other respects it is found also that the electric batteries, which on the first view we might be tempted to believe to be so different, have however a great many relations with each other, and may be reduced to the same system of organization. This will appear evident, when it is considered that the electric fishes are the only ones in which we find aponeuroses so extensive and so multiplied in their surfaces, with so considerable an accumulation of gelatine and albumen in the cells formed by these aponeuroses, and nervous rami so large and of such a length. It is by the union, indeed, of these simple instruments that the electric organ is constituted; and in this state, according to the judicious remark of my colleague Lacepede *, it may be compared to the Leyden flask, or an electric picture, since it is alternately composed of bodies which conduct the electric fluid (the nerves, and the albumino-gelatinous pulp to which the action

* *Histoire Naturelle des Poissons*, vol. ii. Description of the *Gymnotus electricus*, p. 166.

 of

of the nerves is continued), and of non-conducting bodies, fuch as the aponeurotic laminæ, extended through this mafs of albumen and gelatine. What proves that it is on the mechanical arrangement of thefe idio-electric and non-electric elements that the properties of the torpedo depend, is the exiftence of the fame parts in other rays, though thefe fifhes are not capable of producing the fame effects. Thefe parts, fimilar in regard to their intimate nature and texture, are difpofed in a manner entirely different. The nerve of the fifth pair in the rays and fquali is of a confiderable volume, and expands in a medium from which flows a great quantity of albumino-gelatinous ferofity: but this gelatine either is loft on the outfide by tubes which open without the fkin, or is accumulated in a mafs on the fides of the bones of the nofe. In the latter cafe, the gelatine, whatever be its quantity, is of no ufe for the production of electricity. This, no doubt, muft be afcribed to the want of aponeurofes, which divide it into fmall infulated portions—in the fame manner as the Leyden flafk, or the electric picture, would fail of their effect if deprived of the glafs laminæ interpofed between the metallic coatings.

The electric organ, being formed of nerves and aponeurotic laminæ, interlarded, if I may ufe the expreffion, with albumen and gelatine, we ought not to be aftonifhed at meeting with it in families altogether different. All animals have nerves which are loft under the fkin; all thofe immediately below it are more or lefs provided with cellular tiffue: all then have, in fome meafure, the rudiments of an electric organ. If we now fuppofe that nourifhing veffels depofit albumen and gelatine between the leaves of the cellular tiffue which fixes the fkin to the exterior mufcles, we fhall eafily form an idea of the manner in which this depofition may give rife to the exiftence of an electric organ. All this may take place without the influence, at leaft in an immediate manner, of the other organs effential to life. It is a development which takes place almoft without the animal, and which has no action but on the fkin and parts which depend on it; and hence the reafon why fpecies which exhibit alone a development fo extraordinary belong, however, to a numerous genus without prefenting any ftriking anomaly.

I have thought it neceffary, for the benefit of naturalifts who apply to the ftudy of natural relations, to infift on this remark; and I fhall terminate this memoir by another, which in my opinion muft prove interefting to the learned.

I have reafon to believe that the Arabs, at the period no doubt when they cultivated the fciences with fo much fuccefs,

cefs, had approached nearly to the theory of electricity; it is at leaft probable that they referred to the fame caufe the fulminating effects of the torpedo, and thofe, much more terrible, of celeftial electricity. We can form no opinion of their knowledge in natural hiftory but by the names which they have given to moft of the productions of nature. Thefe names have been preferved without alteration; for it is only to the æra when the fciences flourifhed in the Eaft that we muft refer the rational nomenclature ftill employed by the rude inhabitants of Egypt. Every animal in that country, as well as in books of natural hiftory, has two names, that of the genus and that of the fpecies. There is no exception but in favour of the torpedo and the filurus electricus. Every thing which related to the form of thefe fifhes has been neglected, and nothing has been attended to but their aftonifhing faculty of ftriking with torpor all the fmall marine and frefh water fifhes. Though very different, they have been diftinguifhed by the fame name; and, what is very remarkable, this name, *râad* or *raafch*, is that ufed to exprefs thunder. In giving this denomination to the torpedo and the filurus electricus, did the Arabs think of referring the phænomena of animal electricity to celeftial electricity?

Explanation of the Figures, Plate III.

Fig. 1. the torpedo (*Raïa torpedo*).

a, electric organ compofed of tubes.

b, the upper fkin turned back on the fide to fhow the electric organ.

Fig. 2. the red ray (*Raïa rubus*).

a, *a*, aponeurotic tubes which communicate on the outfide of the fkin by peculiar orifices.

b, the fkin of the flanks turned back on the fide.

n, nerve of the fifth pair.

i, focus in which the nerve of the fifth pair expands, and from which proceed, in a radiated form, in feveral bundles, the tubes which open on the outfide of the fkin.

Fig. 3. tranfverfe fection of the electric eel, *gymnotus electricus*.

g, *g*, large electric organs.

p, *p*, fmall electric organs.

v, air-bladder.

m, *m*, *m*, *m*, longitudinal mufcles.

o, vertebral column.

d, fkin feen on the outfide.

c, anal fin.

Fig. 4. *Silurus electricus.*

b, aponeurosis which extends over the whole of the electric organ, that is to say, over a reticulation of tendinous fibres comprehended between that aponeurosis and the skin.

t, thickness of the electric organ.

n, *n*, nerve of the eighth pair.

m, *m*, abdominal muscles.

XXIII. *On Indian Dogs. By Dr.* Barton, *of Philadelphia.*

[Concluded from p. 9.]

It is highly probable that the Indian dog still exists, in a wild state, in the woods of many parts of North America. It is likely that when seen he has been sometimes mistaken for the wolf.

A very intelligent Indian informed me, that in the year 1792, when travelling towards the head waters of the river Miami, which empties into lake Erie, he had met with wolves which barked like dogs, though in other respects they appeared to be little different from wolves. Perhaps future researches will show that these were the real Indian dogs in their wild state. The subject is worthy of further inquiry. If the Indian dog be an hybrid animal, we ought to suppose that he is less common in the woods than the animals from whom he is sprung. Hybrids are, in general, more rare than original species. This observation applies both to the animal and to the vegetable world.

The late Mr. Peter Kalm informed Mr. John Bartram that the dogs which he saw among the Indians of Canada "were just like the dogs in Sweden, and that they had ears sharp-pointed, and standing up like a wolf's. I can remember perfectly well (continues Mr. Bartram) that when I was a boy the Indians came frequently to our house. Their dogs had sharp-pointed upright ears, and we used to think that they were of the wolf breed. Now, whether the Indians had their dogs from the Swedes, who settled in Pennsylvania long before the English settled there, or whether the Indian dogs were natives of North America, and the same kind as those in the north of Europe and Asia, is well worth inquiring *."

The fact mentioned by Kalm, and the hint suggested by Mr. Bartram, have sometimes, for a moment, led me to believe that the wolf-like dog of the northern Indians may have been received from the Swedes, who formed a settle-

* A letter in my possession, dated January 17, 1757, from Mr. John Bartram to Mr. George Edwards.

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ment in Pennfylvania early in the 17th century. But a little confideration has compelled me to relinquifh this idea: for it is certain that the Indians were in poffeffion of this breed of dogs long before the arrival of the Swedes in America.

We have already feen that the Spaniards found domefticated dogs among the Indians of Florida before the middle of the 16th century, almoft one hundred years earlier than the Swedifh fettlement in Pennfylvania. It is not, indeed, certain that thefe dogs were of the half-wolf breed; but it is probable that they were. In the year 1585 the celebrated navigator captain John Davis obferved dogs "with pricked ears" in the lands about Hudfon's Bay*. It is highly probable that thefe dogs were a variety of the half-wolf breed of the Indians. Captain John Smith, who arrived in Virginia in 1607, a few years before the Swedifh fettlement, exprefsly mentions the affinity of the Indian dogs in that country to wolves. I might eafily adduce other inftances. Thefe are fufficient for my purpofe. They evidently fhow that the Indian dog exifted in America before the Swedes planted their firft colony in Pennfylvania: confequently, we have no difficulty in anfwering Mr. Bartram's firft queftion, which I have ftated.

Still, however, Kalm's obfervation is interefting. It leads us to fufpect that the dog of the Indians is common to North America and to the northern parts of Europe. Neither fhould this circumftance, in whatever light we may view the original of the Indian dog, excite our furprife. If, as very many of the traders and others fuppofe, this dog is the produce of the wolf and the common fox, his parents exifted in the old as well as in the new world. He may have been formed in America by the union of thefe two animals; or he may have migrated into America from Europe along with many other animals, which, it is highly probable, owe their original to that portion of the globe, or to Afia. For that America has received fome of its animals (befide its human inhabitants) from Afia and from Europe, I have very little doubt †.

I conjecture it will be found that the dog of the Greenlanders, mentioned by Crantz ‡ and other writers, is only a variety of the Indian dog. And, perhaps, the dogs of the Kalmuc Tartars, which are faid to have a great refemblance

* Forfter.

† See New Views, &c. Preliminary Difcourfe, p. 101, 102.

‡ The Hiftory of Greenland, &c. vol. 1. p. 74. Englifh Tranflation, London 1767. "The Greenlanders (fays this author) have no tame beafts but dogs of a middle fize, which look more like wolves than dogs. Moft of them are white, yet there are fome with thick black hair: they don't bark, but growl and howl fo much the more."

to

to the jackal, or schakal, will also prove to be of the same breed. But with me these must remain, for some time, mere conjectures. For I am incapable of giving such a minute description of the external and internal appearance of the Indian dog as would enable the naturalists of Europe to decide a question not the least curious in the zoology of the new world. In another work I hope to be able to give a much more complete account of this animal than that which I now communicate to the public.

I have said that the Indian dog is a much more savage or unreclaimed animal than the common dog which has been introduced into America from Europe *. This circumstance has not escaped the notice of some preceding writers. But I know of no writer who has deduced from it so important a conclusion as Mr. Zimmermann has done. This truly learned naturalist, after remarking that the Europeans who have visited America have considered the Indian dogs merely as tamed wolves, proceeds to deduce the conclusion, that neither America itself, nor its inhabitants, are so antient as the countries or the people of other parts of the world †.

This conclusion proceeds upon the notion, so ingeniously defended by Mr. Zimmermann, that the dog of the old world is merely the wolf reduced to a state of domestication, and varied, both as to his external aspect and as to his essential qualities or manners, by the influence of climate and other physical causes, during the term of some thousand years ‡. This subject is worthy of some of our attention. I regret, however, that in this place I can only touch it in the most superficial manner. This I shall do under the following seven heads.

I. I may observe, in the first place, that it is by no means probable that the wolf is the sole parent or original stock from whence have proceeded all the numerous varieties of animals which go under the general appellation of dogs. I think it much more probable that these varieties are derived from several different stocks or sources beside the wolf; such as the jackal, the hyæna, different kinds of foxes, &c. &c. In their inquiries into the genealogical history of the dog kind, naturalists, by aiming at simplicity, have only tended to involve the subject in confusion. A comparative view of the internal structure of the supposed parents of the dog kind, and the dogs, has been too much neglected. Some attention, however,

* See page 7. † Specimen, &c. p. 91.

‡ The whole of Mr. Zimmermann's inquiry into the origin, &c. of the dog kind, is well worthy of the attention of the naturalist. See Specimen, &c. § 3. p. 83—98.

however, has been paid to this ſubject. Eſſential differences between the ſtructure of the wolf and the dogs (I mean the common dogs of the old world, for I know not that any anatomiſt has hitherto inſpected the ſtructure of the Indian dog of America) have been diſcovered; differences ſo eſſential, that I think they forbid the idea that the wolf and the dog are one and the ſame ſpecies. I do not, however, deny that the pure unmixed wolf has, in ſome countries, been reduced to the domeſtic ſtate of the dog. But I think it more probable, that even thoſe dogs, which are moſt nearly allied to the wolf, are hybrids, begotten between this animal and ſome other ſpecies of the genus.

II. From their agreement in internal ſtructure, it is much more probable that the jackal or ſchakal (the canis aureus) is one of the principal original ſtocks of the dogs of the old world. Profeſſor Gueldenſtaedt has remarked, that the *cæcum* of the jackal "entirely agrees in form with that of a dog, and differs from that of the wolf and fox." "I may add (ſays Mr. Pennant, whoſe words I have been uſing), that there is the ſame agreement in the teeth with thoſe of a dog, and the ſame variation in them from thoſe of the two other animals *." Moreover, in his manners the common dog is much more allied to the jackal than he is to the wolf, or to any other animal with which we are acquainted. If then this animal, and not the wolf, be the principal parent of the dog kind, the ſpeculations of Mr. Zimmermann ought to have little weight in eſtabliſhing the poſition, that the continents of America are a new creation, and their inhabitants new poſſeſſors of the ſoil. For, I think the form of the Indian dog is very conſiderably remote from that of the jackal, which is not known to exiſt in any part of America.

III. In order completely to eſtabliſh his opinion Mr. Zimmermann ſhould have proved that the dog is certainly derived from the wolf. I have juſt endeavoured to render it probable that the wolf is not the parent of the dogs of the old world; and I formerly† gave ſome reaſons for believing that the Indian dog of America, notwithſtanding the conjectures of Lawſon, and other writers, is not the pure unmixed wolf, but an hybrid, begotten between this and ſome other animal.

IV. But in the old world there are dogs not perhaps more completely domeſticated, or, in other words, not more thoroughly deprived of their ſavage aſpect and manners, than are the dogs of North America. Such are the dogs of the Kalmuck Tartars. And who that attentively conſiders the

* Hiſtory of Quadrupeds, vol. i. p. 262. † See p. 7.

hiſtory

hiſtory of the country in which the Kalmucks reſide will believe that that country is a new creation? Who will venture to conjecture that the Kalmucks themſelves are a new people? Moreover, Kalm's obſervation would lead us to believe that the Indian dogs are the ſame (and of courſe not more ſavage) as ſome of the dogs in the north of Europe.

V. Some animals are very eaſily brought into the domeſticated ſtate. Others are domeſticated with great difficulty. Perhaps there are ſome incapable of domeſtication. If the Indian dog be the offspring of the wolf and the fox, or any other animal, we ought not, perhaps, to wonder that he is ſtill more an *animal ſylveſtre* than the generality of the dogs of the old world; for both the wolf and the fox are with difficulty tamed. In this inquiry we ought alſo to remember that the maſter of the Indian dog is a ſavage. It may readily be conceived that this circumſtance will influence the genius of our animal. Living in the woods, and too frequently badly treated by his maſter, the dog muſt often leave the huts of the Indians, and, perhaps, imbibe from his parents, in the woods, a new tincture of their aſpect and their manners. Even in our cultivated towns, how much do the manners of the dogs ſeem to depend upon the calling of their maſters! It is a fact, that the dogs of our frontier ſettlers have a much more ſavage aſpect than the dogs (the ſame variety) in the villages and populous towns.

VI. In America there were found ſome kinds of dogs which were not leſs domeſticated than the dogs of the old world. Such were the *alco* and the *itzcuintepotzotli*, of which I have already given ſome account. I think it very improbable that theſe two ſpecies or varieties were derived from the wolf. Nor is it certain that they were not a ſpecies of canis eſſentially diſtinct from thoſe of the old world. In whatever light we view them, they ſeem to oppoſe an objection to Mr. Zimmermann's notion concerning the recent creation of America, and the recent population of this great portion of the globe. Could it be proved that the *alco* and the *itzcuintepotzotli* have ſprung from the wolf, it would be natural to infer that an immenſe period of time had elapſed before theſe animals could have been brought into the mild, domeſticated ſtate in which the diſcoverers of America found them.

VII. and laſtly. This is not the place to inquire into the period of the population of America. I have touched upon this queſtion in another work *, and ſhall examine it more fully in a work in which I have long been engaged. Here,

* New Views, &c. Preliminary Diſcourſe, p. 104—109.

however,

however, I may obferve, that many circumftances forbid the idea that America is a new creation, recently emerged from the influence of the ocean. And circumftances, impreffive in their nature, render it extremely probable that many of the nations of America have refided in this portion of the world for fome thoufand years. Trying them by their languages, the Americans will appear to be children of the earlieft human families of which hiftory or the traditions of mankind have preferved any memorials.

Among the almoft innumerable charges which have been brought againft the Indian inhabitants of America, there is one which it becomes the hiftorian of Indian dogs to take fome notice of. The Indians are accufed of great feverity or cruelty in the treatment of their dogs. Mr. Lawfon fays the favages are the "worft dog-mafters in the world, fo that it is an infallible cure for fore eyes ever to fee an Indian's dog fat *." I have already made mention of this refpectable traveller's notion of the procefs by which he fuppofed wolves are turned into dogs †. The faithful father Charlevoix fays, the Indians feed their dogs "but poorly, and never fondle them ‡." Carver, who fo frequently borrows from Charlevoix, fays nearly the fame thing §. It is even faid, that, owing to their fcanty allowance of food, the Indian dogs are often fo weak, that they are obliged to lean againft a tree, or fome other prop, whilft they bark.

It is well known how much ingenuity, eloquence, and fcience, have, within the laft fifty years, been employed to reprefent the Americans as the degenerated, or imperfectly organized, children of the earth. To complete the large volume of calumny againft thefe poor people, even the manner in which they treat their dogs is not fuffered to pafs unnoticed by the hiftorians of the new world. "Prior to their intercourfe with the people of Europe," fays the eloquent Dr. Robertfon, "the North Americans had fome ‖ tame dogs, which accompanied them in their hunting excurfions, and ferved them with all the ardour and fidelity ¶ peculiar to the fpecies. But, inftead of that fond attachment which the hunter naturally feels towards thofe ufeful companions of his

* A New Voyage, &c. p. 38. † See p. 7.

‡ A Voyage to North America, &c. vol. i. p. 79.

§ Travels, &c. p. 416.

‖ They had many tame dogs. The liberality with which the Indians fupplied Soto's men, and the facility with which the men fupplied themfelves with dogs, leave us no room to doubt that tame dogs abounded in Florida.

¶ Their fidelity has been called in queftion. See p. 7.

toils,

toils, they requite their ſervices with neglect, ſeldom feed and never careſs them *."

It would, I believe, be a much eaſier taſk to prove that Dr. Robertſon was unqualified to write the hiſtory of America; to prove that the Indian Americans are not the inferiors of the people of the old world in the meaſure of their intellectual endowments; and to ſhow that more than one-half of the charges which have been brought againſt theſe people are charges reſulting from ignorance or from ſyſtematic zeal, than to prove that the Indians are peculiarly entitled to the character of kind and tender dog-maſters. After ſome attention to this ſubject, I muſt candidly confeſs that I poſſeſs not materials for a ſatisfying defence of the Indian. The charges which have been brought againſt him by the writers whom I have mentioned will be convictive. But why, in this inquiry, if the hiſtorian will condeſcend to mention the fact, and to interweave it with his eloquence, ſhould he forget the hardſhips of the ſavage life? Where the maſter labours under a ſcarcity of food, his ſervants, the animals which depend upon him for their ſubſiſtence, muſt ſhare in the hardſhips and the evils of his ſtate. The miſerable condition of the Indian dogs is a neceſſary reſult of the miſerable condition of the Indians themſelves. This is certain; though the Indians tell us that they keep their dogs poor that they may be light and nimble, and therefore the better fitted for the purpoſes of hunting.

Dr. Robertſon, however, might have found, in the writings of ſome of the authors whom he has repeatedly quoted, mention made of the tenderneſs which the Indians manifeſted towards their dogs in ſome parts of America. The following paſſage in Acoſta ſhould not have eſcaped the hiſtorian's notice. Speaking of the *alco*, the learned jeſuit ſays: "The Indians doe ſo love theſe little dogges that they will ſpare their meate to feede them, ſo as when they travell in the countrie they carrie them with them upon their ſhoulders or in their boſomes, and when they are ſicke they keepe them with them, without any uſe, but only for company †." Hence it appears, that of one ſpecies or variety of their dogs, the Indians, in ſome parts of the new world, were peculiarly careful, and even ſolicitouſly tender.

The Wunamneeh Indians call the dog *allum*, *al-loom*, *mo-e-kan-neb*, and *mé-kan-ne:* the Monſees, *al-lúm:* the Mahicans, *dee-a-oo*, *de-a-oo*, and *an-nun-neen-dee-a-oo:* the Chippewas, *a-lim*, *anu-moſch*: the Meſſiſaugers, *an-nee-*

* The Hiſtory of America, vol. ii. p. 216, 217: London 1788.

† The Naturall and Morall Hiſtorie, p. 301, 302.

mooſh:

moosh: the Ottawas, *an-nee-moo-kau-che*: the Indians of Penobscot and St. John's, *allomoose*: the Natics, *anum*: the Narragansets, *alum*: the Miamis, *aul-la-mo*: the Wiahtanah, *lemah?* the Pottawatameh, *an-ne-moosh*: the Shawnees, *wissi*, *wee-seh*: the Kaskaskias, *remoah*: the Nanticokes, *alum*, and *ihnwállum*: the Mohawks, *abgarijoo? er-har?* the Cochnewagoes, *er-har*: the Oneidas, *er-har*, *ale-haul*, *ale-hall*: the Onondagos, *tschierha*: the Cayugas, *so-waus*: the Senecas, *chee-aah*, and *che-eh*: the Tuscaroras, *cheeth*, *cheetht*: the Wyandots, *nee-a-nooh*: the Sioux, *shúngau*, *chonga*, *shun-gush*: the Osages, *shong-eh*: the Cheerake, *keera*, *keethlah*, *keethlegth*: the Creeks, *ee-fa*, *e-fa*, *ef-fa*: the Chikkasah, *o-phe*, *oo-phe*: the Choktah, *o-phe*: the Katahba, *taunt-see*, *taunsee*, *tase*: the Woccons, *tauh-he*: the Natchez, *worse*: the Mexicans, *chichi*: the Poconchi, *tsi*: and the Chilese, *tewa*.

If the affinity between the Wunaumeeh words, *mo-e-kanneh*, *mé-kan-ne*, and the Latin *canis*, the Italian *cane*, the Neapolitan *cane*, be not accidental, and who, attentively considering the very many affinities that subsist between the languages of the old and new world, will imagine that it is accidental?), we have probably arrived at the knowledge of the real meaning of the Latin word *canis*. *Mékanne*, in the language of the Delawares, signifies "the barking beast." It appears from Dr. Pallas's great work (*Vocabularia Comparativa*) that certain tribes of Semoyads call a dog *kanang*, *kának*, and *konak*; and that the Karassini call it *kannak*.

XXIV. *A short Account of the Improvement in Circular Architecture made by Colonel* TATHAM.

FOR this invention, which appears to be ingenious, and applieable to many important uses, a patent has been taken out by Messrs. John Scott, James Clarkson, William Tatham, and Samuel Mellish. The invention consists in the form given to the bricks or stones to be employed in circular buildings, which is such as to make them lock, as it were, into each other, and that so effectually as to preclude the possibility of their parting joint by any accident whatever when laid down properly.

Two of the vertical sides of each piece employed in such circular structures answer to two radii from a common centre: a circle from the same centre forms the third vertical side; and the fourth side is formed by another circle of a radius as much

much shorter than the last, whatever that may be, as the thickness intended for the wall: they are, in fact, wedge-formed. This is so precisely the case, that where the pieces (to which the patentees have given the name of *Tatham's clumps*) are intended to form solid pillars, or the like, they exhibit only the three first-mentioned vertical sides.

The horizontal, or under and upper sides of the clumps, have a kind of shouldering or protruding part, and a corresponding hollow or depressed part to fit the similar parts of the next course, and these are at the same time so adjusted that each course will break joint with the one before laid; that is, the vertical joinings of every row fall on the middle of the clumps which form the one below and the one above it.

The form given to the shoulderings or joggelings is so ingeniously contrived, that, were a cylinder formed of these clumps, with the two extreme circles tied together by means of long bolts passing up the centre, secured by screws or other fastenings, it might be laid upon its side and employed as a garden roller, without the possibility of any one of the clumps falling out of its place.

It is easy to see that this contrivance is applicable to a variety of purposes: as,

1st, In rural architecture, &c. For example, in cottages, country houses, villas, circular barns; granaries, secure from rats, mice, and other vermin; feeding houses, cattle sheds, summer houses, castles, towers, turrets, battlements, palisadoe work, door steps, stair-cases (secure from fire), pleasure houses on eminences and near the sea, bathing houses, &c.

2dly, In solid work; as columns, colonnades, agricultural rollers, rollers for roads, garden rollers, stone or brick piers in water works, &c.

3dly, To hydraulic and subterraneous architecture, for sewers, culverts, tunnels, conduits; cylinders in bridge work, thereby giving strength, cheapness, waterway, and lightness, to the structure; mills, reservoirs, communications, wells, cesspools, and the like.

4thly, In marine architecture, to dock work, basins, harbours, piers, jetties, light-houses.

5thly, In military architecture, to magazines, block-houses, redoubts, covert ways, lines of communication, watch towers, &c.

6thly, In architecture applying to warehouses and manufactures; for example, circular windows and other apertures admitting light and air, brewers' vaults, boilers, &c. &c.

7thly, Church architecture; for example, circular chapels,

pels, steeples, columns to support ponderous roofs, the hollow ones with stair-cases when wanted, niches, cells, cloisters, vaults, &c.

Explanation.

Fig. 1. *a* is a single clump, having its male point inwards on the side in view; *b* is one with the female point inwards on the reverse of the same clump.

Fig. 2. *a*, one with the male point outwards; *b*, one with the female point outwards. Each of these figures, 1 and 2, represent different kinds of clumps, which being laid, one kind at a time, in a circular form, with the same sides uppermost, will make one course: see fig. 5. for an example of one course of clumps, fig. 1, *a*. Then add one course of fig. 2, fitted in male and female (or joggled); and so on alternate circles, fig. 1 and fig. 2, to the end of the length designed, terminating the same with a cast iron plate, flaunch piece, or key clump, with two male sides so as to admit of taking down for repairs, &c. This method will form a broken joint, such as the one exhibited in perspective view fig. 9.

Fig. 3. is an elongated clump for forming solid columns, colonnades, &c.; *a* having its male point inwards, and *b* having its female point inwards.

Fig. 4. a clump elongated as in fig. 3. *a* shows the view with the male point outwards: *b* the reverse of the same clump, with the female point outwards. These clumps are to be laid into each other in the same manner as fig. 1 and 2, to form a column of solid work, of which a section is represented in fig. 8. If it is intended to construct a circular staircase with dome-light, &c. on this principle, one or more clumps in each course of work (be the same of brick, earth, stone, or other material, according to the design and extent,) must be of the long kind, to form the *step* of the stairs; all the rest of short clumps, fig. 1 and 2, to admit light and access through the aperture of a spiral ascent.

Fig. 5. *a*, *a*, *a*, shows the position of clumps *a*, fig. 1, according to the mode of laying them, with the male point inwards: *b*, *b*, *b*, shows the reverse of the same clump with the female point inward. The bottom circle in this and the next figure shows merely the position which a continuation of the clumps would take.

Fig. 6. clumps with blank sides uppermost: these are merely for laying the first course on the ground, or, in some instances, for saving the expense of a cast iron rim next the flaunch of a branch piece. Their reverse must be always indented, or joggled, to fit the next course of clumps. If it is

 required

required to form a flush edge, such as the cheek of a window or door, it can be done by cutting down the clumps into half clumps, as represented by the dotted line X, X, fig. 9. Raviels, rabbits, grooves, &c., and returns of corners, elliptics, &c. must be specifically moulded on the same principle; or girders, ties, &c., may secure any variation by means of suitable cast iron clamps, modified according to the particular contingency.

Fig. 7. a section of a well or pipe, &c. the surface of the circle in view being put together with clumps fig. 2, the male side *a* pointing outwards.

Fig. 8. shows the plan of a solid column formed of elongated clumps of the kind *a*, fig. 4, the male points outwards being in view. As this same modification contracts the circle to a smaller column, in that case fewer pieces will be required.

Fig. 9. is a perspective view, showing a segment of the work (part of a circle) formed out of six clumps laid in their order from figures 1 and 2, the bottom course having a blank side as described fig. 6.

Fig. 10. part of a clump main pipe, showing the manner of flaunching in a cast iron branch piece in order to join the same to a branch main. This can be performed with the help of an iron rim (joggled) as represented in fig. 11; or it can be fitted to blank sides next the flaunch, and the opposite end of the bolt can be counter-sunk into perforated clumps, having the prominent ends fitted with a male and female screw, in order to slide the flaunch piece in or out as occasion demands.

Fig. 11. a cast iron rim indented or joggled to fit a course of clumps as represented on the surface in view, in order to admit the flaunch to slip in and out as required on its smooth surface.

Fig. 12. a plain cast iron flaunch for joining a clump main in suitable lengths to be occasionally taken down: they may also be laid in lengths by means of a key clump, having two male sides to have the joints banded with a hoop.

Fig. 13. shows the mode of fitting the prominent point of the flaunch bolt by means of a male and female screw, so that the flaunch piece may be slided into or out of its birth at option, without hanging on the flaunch plate or joins.

XXV. *On*

XXV. *On the Freezing Point of Tin, and the Boiling Point of Mercury; with a Description of a Self-registering Thermometer invented by Mr.* James Crichton, *of Glasgow* *.

Some time ago, having made some high ranged thermometers, I wished to try their correspondence at high temperatures. I procured for this purpose $1\frac{1}{2}$ pound of the best essayed tin (block), and, after suspending two thermometers upon a sliding support, I melted the tin in a heat of from 20° to 30° above the melting point: I then lowered my thermometers down into the metal, and observed the mercury to sink *gradually* in both till it arrived at 442°; then it *instantly* sunk to 439°, and as instantaneously rose to 442°. At this temperature the mercury remained perfectly stationary for five minutes, at which time the metal became solid to the centre of the crucible. After observing this fact, which to me was new, I waited upon Dr. Mickleham, and requested that he would be present when I should repeat the experiment, to assist me in discovering the fallacy, if there was any. We then procured, from another work, the same quantity of tin as before, and repeated the experiment several times with the same result.

Another accurate standard point, that of 442°, for adjusting thermometers, has thus been ascertained; a circumstance which, judging by the use it will be of to myself in constructing high ranged thermometers, I think too important to be withheld from chemists and others who may wish to avail themselves of it.

Before I quit the subject of mercurial thermometers I beg to state another fact which may also be of use to the philosophical world. Quicksilver does not boil at 600°, but at 655° at the lowest. The precise point I have not yet found leisure enough to ascertain.

I shall now describe a registering thermometer fit for meteorological purposes, which I have lately invented and constructed, and which some of my friends have requested me to make public. Its action depends on the different degrees of expansibility of different metals when exposed to a change of temperature. (See Plate III.)

The length of the instrument is about 13 inches. Fig. 1. represents a front view of it, and fig. 2. a side view: the let-

* Communicated by the Author.

ters of reference are the ſame in both, where they can be applied.

The bar A, of which the ſide BC is of iron, and the other DE of zinc, is about one inch broad, a quarter of an inch thick, and eight inches in length. It is firmly fixed, at the lower extremity I, to a board *a*, *b*, *c*, *d*, made of mahogany.

On the application of heat, this bar, by the ſuperior expanſion of the zinc, is inclined at the top towards B. In the upper end of the bar there is a pin (ſeen at A, fig. 2.) which goes into the fork-like opening L of the index LM (fig. 1.), and carries the ſhort end of this index along with it; conſequently the long end is carried along the ſcale from 0° towards 100°.

When the inſtrument is expoſed to a lower temperature, the movement is exactly the reverſe of what I have been deſcribing.

Beneath the index LM are two others on the ſame axis G, one of which can be carried towards the right, and the other towards the left, by means of a pin which goes through the firſt-mentioned index at H. By this means, the greateſt and loweſt degree of temperature that occurs from the time the thermometer is ſet or adjuſted till it be again conſulted, is accurately marked.

In adjuſting the thermometer for obſervation, all that is neceſſary is to bring the two ſmall indexes immediately below the broad one. As the laſt-mentioned one is moved backwards or forwards by variations of temperature, it carries one or other of the ſmall ones along with it, by means of the pin H, leaving one of them at the higheſt and the other at the loweſt degree that may have occurred from the laſt time of adjuſtment.

The face of the upper part of the inſtrument is covered with a glaſs door, the hinges of which are at N and O.

The greateſt range of any thermometers of this kind which I have yet made, is from 10° below to 100° above 0°. This inſtrument proves very accurate in its indications.

XXVI. *Memoir on the Chemical Nature of Ants, and the ſimultaneous Exiſtence of two Vegetable Acids in theſe Inſects.* By A. F. Fourcroy*.

1ſt. So much has been already ſaid in regard to ants and their acid, that it appears nothing more remains to be added

* From *Annales du Muſeum National*, No. 5.

on

on the ſubject. Since the time that Samuel Fiſher firſt deſcribed this acid in 1670, and taught a method of obtaining it by diſtillation, till citizen Deyeux confirmed by exact experiments the identity of the acid of ants with the acetous acid, (an identity firſt announced in 1749 by Margraff, then in 1777 by Ardviſſon and Oëhrn, and afterwards by Bergman,) all that chemiſts have done on this ſubject ſeems merely to be, that ſome of them have maintained the ſuppoſed analogy; while others have wiſhed that this analogy ſhould be only apparent, and that the formic acid ſhould be conſidered as a peculiar acid *ſui generis.* I do not ſpeak here of the opinion of Thouvenel, who pretended that the acid of ants was the phoſphoric acid, becauſe this opinion was ſupported by no poſitive fact: I thought it might be ſtill uſeful to reſume the analyſis of ants; and the reader will find that, having been employed in this reſearch with C. Vauquelin, it preſented to us ſome facts which had eſcaped our predeceſſors.

2d. Having cleaned the ants which were collected in the wood of Boulogne, and of that kind called by Linnæus *formica rufa,* they were bruiſed in a marble mortar. During this operation a vapour was diſengaged of an odour ſo ſharp and pungent that it hurt the eyes, and could be compared to nothing but the acetic acid or radical vinegar.

3d. The ants thus bruiſed were put to macerate in alcohol for ſeveral days, and in a temperature of about 68 or 70 degrees the alcohol aſſumed a yellow colour.

4th. The alcoholic infuſion of ants ſubjected to diſtillation furniſhed an inflammable liquor ſlightly acid. During the diſtillation there was formed in the liquor a browniſh depoſit which was collected on a filter.

5th. The acid liquor which remained after diſtillation, when filtered and ſeparated from the depoſit, was ſaturated with lime. It then became brown, thick, and acquired a nauſeous and pungent ſavour. By blowing through a tube into the thick liquor there was formed a multitude of bubbles, which exhibited the ſame priſmatic colours as ſoap bubbles.

6th. This combination of the acid of ants with lime, when ſubjected to the teſt of different re-agents, exhibited the following phænomena:

a. Mixed with concentrated ſulphuric acid it exhaled the odour of vinegar.

b. With nitrate of lead it gave an abundant white precipitate.

c. With nitrate of ſilver a yellowiſh precipitate.

d. With muriate of barytes there was nothing ſenſible.

e. Ammonia produced no change in it.

f. Alcohol formed a ropy and ductile precipitate.

7th. A part of the thick liquor being mixed with half a part of concentrated sulphuric acid and two parts and a half of water, there was immediately formed a very thick magma. This mixture was subjected to distillation, and the product was divided into three parts. They were all clear and colourless: they had an empyreumatic odour, and a very strong acid taste.

The residuum of this distillation had acquired a very dark brown colour, and a disagreeable burnt taste, though it had not been carried to dryness.

The first product tried with acetite of lead gave no signs of the presence of the sulphuric acid: the second and third gave the same result; which proves that they contained no sulphuric acid.

This acid distilled and combined with potash furnished real acetite of potash which attracted the moisture of the air; exhaled, by the addition of concentrated sulphuric acid, a strong vapour like that of radical vinegar; and in a solution of nitrate of mercury formed a flaky precipitate like common acetite of potash.

The greater part then of the acid of ants is acetous acid, as C. Deyeux has already proved by a careful analysis and experiments *.

8th, The calcareous combination of the acid of ants, obtained by infusing them in alcohol, exhibited to us a very remarkable character. In a solution of acetite of lead it formed a very abundant deposit, which was redissolved by

* Bergman had found in it some resemblance to the acid of vinegar; the following is what he says on this subject:—Hoc acidum indole aceto proximè accedit, in variis tamen differunt. Prius cum magnesia, ferro et zincò crystallisabiles præbet sales, posterius nonnisi deliquescentes. Magnesia formicata in primis notatu digna est. In another part of his works, *A Dissertation on Magnesia*, Bergman speaks also of the formic acid, and describes the properties of the salt which it forms with magnesia as follows:—Acidum formicarum magnesiâ saturatum aquam deserens fundum petit, abundante autem acido solvendum et evaporatione crystallos deponens, quæ saporis fere expertes ægerrime aquâ solvuntur, in igne non funduntur; sed tamen, parum decrepitant, subito nigrescunt, tandemque in pulverem fatiscunt album, in acidis effervescentem quum acidum formicarum sub destructione magnesiam præbeat aëream. Crystallorum figura est hemisphærica, plano secante sursum verso, paulum concavo, polito, striisque, oculo armato vix discernendis, è centro radiante: hinc luculenter aceto dignoscitur acidum formicarum, cui alioquin indole proximè accedit, illi tamen, æquè ac acidis vitrioli nitrique phlogisticatis, magnesiam eripiens hujus salis dimidium pondus est ex magnesia. Una ejusdem pars tredecim requirit aquæ, ut solvatur in calore quindecim graduum; spiritus vini eundem non suscipit.

the

the acetous acid, and even by that which was obtained in the ſolution above deſcribed, No. 7.

As this experiment ſhows that the acid taken from the ants by alcohol, and combined with lime, contained ſomething elſe than acetous acid, ſince this calcareous ſalt precipitated acetite of lead; and as this different matter was not volatile, ſince the product of the diſtillation with ſulphuric acid did not produce the ſame effect, we tried to find it again in the reſiduum of the diſtillation: but this reſiduum contained ſo much ſulphuric acid that it was impoſſible for us to ſucceed; we therefore had recourſe to the following experiment.

9th. A part of the combination of the formic acid with lime was mixed with a ſolution of nitrate of lead, and there was immediately formed a very abundant precipitate of a yellowiſh colour, which when put upon burning coals, after having been well waſhed and dried, became immediately black, exhaled an animal and ammoniacal odour, while the lead was reduced to a metallic ſtate.

Sulphuric acid diluted with about ſix parts of water was poured over this precipitate reduced to fine powder. At the moment of mixture the powder remained at the ſurface of the liquor as if it had been a fat ſubſtance, and it did not become mixed with ſulphuric acid till after long agitation.

When the mixture was well made the volume of the precipitate was diminiſhed: it became heavier and whiter. The liquor then had a ſlight acid and ſaccharine ſavour, which was deſtroyed by the addition of the ſulphuric acid, and was ſoon ſucceeded by a nauſeous ſavour. It precipitated ſlightly muriate of barytes, which indicates ſome traces of ſulphuric acid. It precipitated lime water only very weakly; but at the end of ſome hours there were formed a great many cryſtals at the ſurface of the liquor, and on the ſides of the glaſs containing the mixture.

It precipitated in abundance nitrate of mercury, and thoſe of ſilver and lead.

Combined with barytes it gave a reddiſh ſolution of a ſaline and pungent ſavour. This combination reduced to a ſmall volume did not cryſtallize; a ſlight pellicle only was formed at its ſurface. Potaſh did not ſeparate the barytes from this combination, but the alkaline carbonate produced a precipitation. The oxalic acid formed in it a very abundant depoſit, but the tartarous and citric acids produced in it no change.

10th. The facts here detailed indicate to us that the matter combined with lime along with the acetous acid was of the nature of the malic acid; but to be more certain we examined it comparatively with the latter, combining both of

 them

them with the fame fubftances. Without here entering into a tirefome account of thefe comparative experiments, we fhall content ourfelves with faying that thefe two compounds exhibited phænomena abfolutely fimilar.

Ants contain then, and confequently form, malic acid, like vegetables. It is no doubt the prefence of this acid which had mifled the chemifts who preceded us in this labour. While they acknowledged in the acid of ants a great analogy with vinegar, they however found differences which induced them to confider it as a particular acid; and thefe differences arofe from the prefence of the malic acid in the acetous acid of ants.

Diftillation of the Product of Ants treated with Alcohol.

11th. The ants, exhaufted by alcohol, furnifhed a limpid and flightly alkaline water, a reddifh brown oil, thick and exceedingly fœtid. The firft liquor, diluted with water, and filtered to feparate the oil, produced a flight effervefcence with acids.

As it emitted at the fame time an odour of vinegar, eafily diftinguifhed amidft the fœtidnefs by which it was accompanied, a certain quantity of it mixed with fulphuric acid was diftilled, and we obtained a colourlefs acid product of an empyreumatic odour, which contained a fmall quantity of acetous acid. Was this acetous acid completely formed in the ants exhaufted by alcohol, or was it formed by the action of the fire?

The product of the diftillation of the exhaufted ants contained then a fœtid empyreumatic oil, carbonate of ammonia, and acetite of ammonia, all diffolved in a large mafs of water.

Examination of the Matter which feparated from the Alcohol during the Diftillation mentioned in No. 4.

12th. The reader will remember that the alcoholic infufion fubjected to diftillation fuffered to be depofited a brown fubftance which had been feparated from it by the filter. This fubftance was of fo dark a red colour that when feen in a large mafs it appeared to be black: when dried it was brittle, its fracture was fmooth and brilliant like that of refin, it had no fenfible favour, it was not foluble in water; and this may ferve to explain its precipitation in proportion as the alcohol evaporated. Though infoluble in water, when macerated a long time in that fluid it communicated to it a flight fawn colour, owing, in all probability, to a fmall quantity of extractive matter interpofed between its parts.

Alcohol

Alcohol ſlightly heated over this ſubſtance diſſolved the greater part of it. It aſſumed a pretty dark red colour: there however remained a browniſh matter, which did not combine with that liquid whatever quantity of it was added. This alcoholic ſolution became milky by the addition of water, and at the end of ſome days there was ſeparated a reſin-like depoſit ſoft and ropy, of a reddiſh colour and a very diſagreeable nauſeous taſte, ſlightly ſoluble in water, ſince it communicated to it a little of the colour and of the nauſeous taſte. This depoſit is a fat matter of a peculiar nature.

The browniſh matter not diſſolved by alcohol, already mentioned, appeared to us to be albumen, which the moiſture, and perhaps the acid contained in the ants, contributed to render ſoluble in alcohol. This albumen was coagulated by the heat, and precipitated with the fat matter in proportion as the alcohol was volatilized. When placed on burning coals it decrepitated, became corneous, ſwelled, and puffed up, emitting white fœtid ammoniacal fumes: it left on the ſupport a large and light charcoal. It was in no manner ſoluble in water; it contained a little hydrogenated carbon, which gave it a browniſh colour.

13th. A portion of the ants exhauſted by the action of alcohol was ſubjected to diſtillation in an open fire. There remained a charcoal, which, like all thoſe of animal ſubſtances, burnt with difficulty, and left, after long combuſtion, white aſhes, which contained nothing but phoſphate of lime.

This was proved by treating it with nitric acid, which diſſolved the greater part of it without effervеſcence, and by adding to the ſolution ammonia, which formed in it a white gelatinous depoſit which exhibited all the properties of phoſphate of lime.

The portion of aſhes which did not diſſolve in the acid was ſilex; but as the incineration had taken place in an earth crucible, this ſubſtance aroſe, in all probability, from that veſſel. However, to aſcertain whether this earth had been really furniſhed by the crucible, ſome of this charcoal was burnt in ſmall portions in a crucible of platina until we obtained a quantity of aſhes ſufficient to be ſubjected to examination, and the following reſult was obtained:—150 parts of charcoal of ants were reduced in an ignited platina crucible, at the end of ſeveral hours, to 22 parts of aſhes; 14 parts of theſe aſhes were diſſolved by nitric acid; the eight parts not diſſolved were ſand mixed at firſt with the ants.

It reſults from this experiment that the oſſeous ſkeleton of ants is formed, like that of warm-blooded animals, of phoſphate of lime. It is not improbable that the long and ſtrong

calcination

calcination to which it was neceſſary to ſubject their charcoal in order to incinerate it, decompoſed this ſalt, and carried it to the ſtate of lime: to confirm this conjecture would have required more of the charcoal than we were able to procure.

14th. It reſults from this analyſis that ants are formed of a large quantity of carbon united to a ſmall quantity of hydrogen, and no doubt alſo to a little oxygen. This compound is mixed with phoſphate of lime, which conſtitutes the ſolid part or the ſkeleton of the inſect. Ants, beſides the preceding compound, contain a pretty large quantity of reſin, ſoluble in alcohol, which ſeems to exiſt in them completely formed, ſince the application of this re-agent is ſufficient to extract and obtain it ſeparately. It is probable that they conceal alſo ſome parts of animal albumen and gelatine; but as theſe animals were ſubjected to diſtillation immediately after their treatment by alcohol, it was impoſſible to obtain the two materials ſeparately.

What ought to be moſt intereſting to chemiſts among the reſults obtained by the analyſis of ants, is the preſence of the acetous and malic acids in theſe inſects. Theſe acids, as appears, exiſt in them in a very large quantity and in a very conſiderable ſtate of concentration, ſince in bruiſing them in a mortar there is diſengaged, as already obſerved, an acetic acid vapour ſo ſharp and penetrating that it is impoſſible to endure it even at the diſtance of three feet. It appears alſo that acetous acid continually exudes and diſtills, as we may ſay, from theſe animals; for they leave traces of it on the bodies which they traverſe. All chemiſts know, that if moiſtened turnſole paper be put into an ant-hill, or even if it be ſuſpended at ſome diſtance, it ſoon acquires a red colour. It is known alſo, that if a certain number of ants be collected in a ſmall quantity of milk it becomes curdled; and that if ſugar attacked by ants, and on which they have remained ſome time, be put into milk, it curdles in the ſame manner. The acidity of ants is proved beſides by the ſtrong impreſſion they make on the mouth when chewed: this impreſſion is almoſt as ſtrong as that produced by radical vinegar. There is reaſon to preſume that it is this acid in a concentrated ſtate, which by inſinuating itſelf into the places bit by ants renders them ſo painful, and cauſes the parts wounded by theſe inſects to ſwell.

One is aſtoniſhed on the firſt view at the quantity of acid which theſe inſects continually furniſh, and in particular that they can live in the midſt of ſo ſharp a liquid; but it is probable that this acid is ſeparated from the other humours by peculiar veſſels which have no communication with the eſſen-

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tial organs of life, and which open only on the outſide of their bodies. Anatomy only can unveil to us this remarkable apparatus of ſecretion.

15th, In regard to the malic acid which in ants accompanies the acetous acid. We ſhall terminate this memoir by a general remark on the exiſtence of this acid in organic compounds.

Few vegetable acids are ſo generally and ſo abundantly diffuſed throughout nature as the malic acid; and, though it has not been long known in compariſon of many others, it has been diſcovered in a multitude of ſubſtances, and its properties have been carefully ſtudied.

It has been found in fruits with ſeeds, with ſtones, and in a great number of berries.

It exiſts in a multitude of plants in the ſtate of malate of lime. The joubarbes, craſſula, and cotyledons, meſembryanthemum, ſedum, and even aloes, contain more or leſs conſiderable quantities of it, according to the analyſis made by C. Vauquelin, and inſerted in the *Annales de Chimie.*

It is found in abundance in the liquor which is ſeparated by the hairs of chicken peaſe (*cicer arietinum*), where it is accompanied with a ſmall quantity of oxalic acid and by ſome atoms of acetous acid.

It is formed by the action of the nitric and oxygenated muriatic acids on all vegetable ſubſtances, and in particular on ſugar, gums, ſtarch, honey, &c.: it always precedes the formation of the oxalic acid by theſe re-agents: vegetable and even animal ſubſtances are conſtantly changed into malic acid before they are converted into oxalic acid, by the acids above indicated.

It is thus that blood, urée, the uric acid, and jelly, when treated with either of the acids above mentioned, are firſt changed into malic acid, and afterwards into oxalic acid if the action of the acid be continued in a powerful manner; but it is always united with ammonia when it ariſes from animal matters, becauſe there is formed at the ſame time a certain quantity of that alkali.

It is not vegetables only that continually give birth to the malic acid: animals are equally ſuſceptible of producing it: it is in the claſs of inſects in particular that this property is manifeſted.

It appears that the malic acid is in ſome meaſure the firſt ſtage of acidification in the proceſſes of nature and of art. It precedes in a ſpecial manner the formation of the oxalic and acetous acids, becauſe it contains a greater quantity of the radicals, or of carbon and hydrogen, and conſequently

lefs oxygen than they do. It is that of all the vegetable or animal acids which retains in the fulleft manner the nature of the animal or vegetable fubftance from which it has been formed; it is that which is decompofed with the greateft eafe by the action of the fire. Preceding all the vegetable acids, by ulterior and fucceffive elaborations it produces the tartareous, citric, oxalic, and acetous acids: it is by lofing a part of its radicals, which are converted into water and carbonic acid by atmofpheric oxygen, that it paffes itfelf to the ftate of thefe other acids; and though none of the latter but the acetous acid has yet been found in animals, there is reafon to believe that all the reft will be found.

The malic acid is then formed by living plants: it often exifts in them in its full purity: fometimes it is found in them united to lime, and no doubt to potafh, according to the nature of the circumftances which accompany its formation. It is alfo formed during the life of certain animals, particularly in ants, and certainly in many other infects: in a word, it is produced by the action of the nitric and the oxygenated muriatic acids on animal and vegetable compounds.

Nature then, every time it can difpofe of the neceffary principles, tends to form malic acid; and there is no reafon to doubt, that if plants were examined when very young, at which time they are all acid, the malic acid would always be found prefent in them. Thefe fucceffive changes afterwards give birth to the other acids already mentioned, and which may be found by further analyfes in animals, as it has been found in vegetables.

XXVII. *On the Property which the Acetic Acid poffeffes of diffolving Camphor and various effential Oils.*

SIR, *To Mr. Tilloch.*

I AM fenfible that an apology is neceffary for obtruding on you and on your readers a fubject which may appear, on firft view, to have little claim to general attention. If the rights and privileges of an individual were alone involved on this occafion, I fhould not have requefted a place in your Magazine for the following ftatement. But it is furely matter of general concern, that the appropriation of inventions and improvements fhould be dealt, with ftrict juftice, to their authors: for the profpect of this diftribution of "honour where it is due" is one of the moft animating principles of action; and the extinction of this motive would certainly fol-

low an indifference, on the part of the public, to the claims of inventors.

More than fifteen years ago, during the delivery of a courſe of lectures, by my father, in this town, he had occaſion to notice a property of the radical vinegar, or acetic acid, which had not, to his knowledge, been before obſerved; viz. its property of diſſolving camphor and various eſſential oils. The compound was found to poſſeſs a moſt pungent and agreeable odour; and as the *vinaigre des quatre voleurs* had gained much reputation in obviating infection, it occurred to him that the newly diſcovered ſolution would have ſtill more powerful effects in conſequence of its high ſtate of concentration. A bottle of this preparation he gave to a late active magiſtrate and philanthropiſt (J. B. Bayley, Eſq. F.R.S.), who, in the courſe of an unwearied and undaunted exerciſe of his public function, was frequently expoſed to the danger of foul and infected air. Mr. Bayley was highly gratified with its effects, and not only made conſtant uſe of the aromatic vinegar on the bench, and on his viſits to the priſon, but introduced it to the adoption of ſeveral of the judges and principal gentlemen at the bar. He alſo firſt ſuggeſted to my father the propriety of benefiting by his diſcovery, and was the medium of a connection with Mr. Bayley, perfumer, in Cockſpur-ſtreet, London, which has continued to the preſent day.

The aromatic vinegar, like every other article in general demand, has been a frequent ſubject of imitation. But it is not of this that I complain; for, in conſequence of unremitting attention, our preparation has maintained a decided ſuperiority over all others, both as to quality and extent of ſale. The occaſion of this appeal to your readers is, that one of theſe imitations has lately been ſanctioned by the name of a reſpectable phyſician, who, though not expreſsly, yet by implication, has conferred on another the credit of that invention, which, in juſtice, belongs to my father. (See a letter from Dr. Trotter, phyſician to his majeſty's fleet, contained in an advertiſement publiſhed in the newſpapers by a London druggiſt.)

From the recommendatory letter of Dr. Trotter it is evident that he was ignorant of any prior claim; and he was therefore made acquainted by my father, in the moſt reſpectful terms, with the facts which have already been laid before you. To this letter the doctor has made no reply, though he declared verbally to a medical gentleman, that my father's preparation had never happened to fall in his way; but that, if it had, he ſhould with equal readineſs have given teſtimony

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in its favour. The advertifement, however, continues to be regularly inferted; and I therefore deem it expedient to appeal thus publicly againft fuch a proceeding; efpecially in behalf of a man who has imitated the original only in copying, with unblufhing effrontery, an advertifement drawn up by myfelf.

I believe there are few of your readers who will not agree with me, that the ordinary forms of civility required that Dr. Trotter fhould have taken further notice of the letter addreffed to him; that fuch an attention ought to have been paid to one of the oldeft practitioners of medicine in this country; and that more refpect was due to a man (whom I truft it is not unbecoming in me to characterize, in terms already publicly applied to him *viris laudatis* *) "refpectable in fcience and in literature," and "diftinguifhed by ingenuity, honour, and the ftricteft integrity."

I remain refpectfully, Sir, your obedient fervant,

WILLIAM HENRY.

XXVIII. *A general View of the Coal Mines worked in France, of their different Products, and the Means of circulating them. By* C. LEFEBVRE, *Member of the Council of Mines, of the Philomatic Society, &c. &c.*

[Continued from p. 76.]

Department of Ardennes.

THERE are no coal mines known in this department.

Refearches have been made at Etion, but without fuccefs. They were begun in fchiftous ftrata, which exhibited no indication fufficient to caufe the labour to be continued; and the manner in which they were conducted was calculated only to produce lofs, fince thofe who directed it followed the courfe of the fchiftous ftrata, inftead of traverfing them to difcover the changes, if there were any, in the order of the ftrata.

This department receives coals from that of Ourthe, which are conveyed to it up the Meufe.

Department of Arriege.

This country (7), abundant in metallic fubftances, and particularly in iron mines of an excellent quality, poffeffes no coal mines worked.

C. Vergniez-Bouifcher, proprietor of the forges of Vic-

* Dr. Aikin and Dr. Percival.

deffos,

deſſos, diſtinguiſhed by his knowledge and his zeal for improving the iron manufactory, has announced indications of coal at Monteſquieu near Foix; and Duhamel, the engineer, has found ſome alſo at Mas-'dAzil.

Department of Aube.

No coal mines are worked in Aube: the general compoſition of the ſtrata of the earth, which exhibit only chalk or beds of ſhells, affords no reaſon to conceive any hope of diſcovering collections of this combuſtible mineral, unleſs it be at great depths, and after having traverſed the whole thickneſs of the beds of chalk and ſhells.

It receives no coals but thoſe which are conveyed on the Seine, or which are carried up by La Marne and the river Aube.

Department of Aude.

Coals are found in the neighbourhood of Caſcaſtel (8), Quintillan, Ruchan, and the mountains of Fabrezan.

The mines worked near Caſcaſtel, Quintillan, and Segur, furniſh about 14000 myriagrammes of fuel per annum.

The products of the other mines are not known, nor do we poſſeſs any certain information reſpecting the price at which the coals are ſold. It is probably very low, becauſe there is very little conſumption for theſe mines.

The proprietors complain loudly of the roads, and wiſh they were repaired; which would facilitate the tranſportation of coals to Perpignan.

It would be uſeful alſo, if it were poſſible, to provide means for conveying the products of the mines of Fabreſan to the banks of the Aude.

Department of Aveyron.

This department (9) is one of the moſt abundant in coal mines. It is intereſting alſo on account of ſeveral other mineral ſubſtances, and particularly of thoſe proper for ſupplying ſulphates of alumine and of iron (common alum and green copperas), which are found there in great plenty in the cantons of Milhau, Saint-Affrique, and ſeveral others.

The collections of coal known near Cranſac, Vialarets, Livignac, and Montignac, and the neighbouring places on the borders or at a little diſtance from the river Lot, are inexhauſtible, and for the moſt part can be very eaſily extracted.

In the year 3 theſe mines produced above 500,000 myriagrammes, and the price was not more than five cents per myria-

myriagramme. At present it is no more than one cent for the same quantity delivered at the mine, but delivered at Villefranche they cost from 12 to 15 cents.

These coal mines can furnish a long time for an immense consumption, especially if more care were taken in working them. The proprietors of the superficial soil attack them on all sides, and with the greater ease, as the strata and collections of the coal are uncovered, or are generally met with at a small depth; so that the whole of this country presents a multitude of pits begun at the surface, and abandoned when the water or shaking of the ground excites a fear of some accident.

Besides the waste which results from this bad method of working, and the obstacles it creates for the future, the carelessness and negligence of the workmen have given rise in this country to a destructive scourge which daily increases its ravages.

Strata of coal have been set on fire at Fontaignes, Moitot, and in several other places. The conflagration spreads, and is fed even in the bosom of the earth. The calcined surface of the ground for a considerable extent exhibits nothing but the arid and distressing picture of the absence of all vegetation and of the existence of all life.

The places already mentioned in the neighbourhood of Lot, and in the canton of Cransac, are not the only ones in this department where coal mines are found; some are known also in the neighbourhood of Milhaud, on the borders of the Dourbie; at Megamel and Lavergne in the county of Séverac; at Bertholéne, and at Sensac in the environs of Rhodez. A new mine has been opened in the last-mentioned place this year by the care of the prefect.

The annual product of the coals worked in these different places amounts to 220,000 myriagrammes, and might be rendered much more considerable.

C. Saint-Thorent, prefect of Aveyron, has been convinced of the importance of turning to advantage the different kinds of mineral riches with which this country abounds, and he has consequently resolved to carry thither that knowledge and activity, by the help of which this department may become one of the most interesting in regard to the products of national industry. This magistrate had requested that an engineer might be sent thither; and C. Blavier, the person employed for that purpose, soon discovered, not only the existence of several mineral substances never before found in these countries, but the speedy means of working them, and of giving rise to very productive

productive eſtabliſhments *. The prefect has requeſted, and obtained permiſſion, for this engineer to be ſettled at Aveyron, charged merely with the direction of this department.

C. Saint-Thorent has already taken meaſures to facilitate the communications and to increaſe the number of the highways in this country, which is in want of ſufficient means of circulation. The utility of rendering the Lot navigable for boats above Cahors has not eſcaped him. The indifference which has been ſhown, and the delay which has taken place in the execution of this project, muſt ſurpriſe all thoſe who are acquainted with the immenſe collections of excellent coal which might be dug up on the banks of that river towards Aubin, Livinhac, and Bouſquet, and who conſider the valuable advantages which might reſult from eſtabliſhing an eaſy mode of conveyance for theſe coals to the departments of Lot, Lot and Garonne, and as far as Rochelle and Bourdeaux, where the products of theſe rich mines would baniſh the uſe of foreign coals, or at leaſt render the introduction of them unneceſſary.

Department of the Mouths of the Rhone.

The only part of this department (10) which has hitherto given riſe to the extraction of coal is that of the ſouth-eaſt, near to the department of Var. The coal mines are ſituated in particular in the environs of the communes of Gardanne, Fureau, Tretz, Peynier, Belcodene, Saint-Savournin, Auriac, Roquevaire, and Gemenas.

The greater part of theſe mines are badly worked, by the proprietors of the ground, or by renters who enter into an engagement with them for permiſſion to dig in their lands. The pits are never carried to a great depth: they are abandoned on the leaſt obſtacle which occurs in the courſe of the labour, which in general is not very ſafe for the workmen.

Theſe coal mines are found in ground covered by calcareous ſtrata, which are even often mixed with carbonate of lime. The coals are of a moderate quality, eſpecially for the purpoſe of forges. They do not cake, and form a hollow fire. It appears, however, that the iron maſters of the country find means to employ them; but it is only with difficulty.

The quantity of the coal extracted in this country is eſti-

* C. Blavier has diſcovered mines of copper and of lead, new indications of coal, and, in particular, a very rich and very abundant iron mine, diffuſed over an extent of more than two chiliometers, in the neighbourhood of the coal mine of Senſac, near Rhodez. This diſcovery will give riſe to the eſtabliſhment of founderies, for which the coals will be employed. He has found alſo conſiderable depôts of turf in ſeveral parts of this department.

 mated

mated at about 320,000 myriagrammes annually. The mean price is from 8 to 10 cents per myriagramme delivered at the pits. The principal places of consumption are Aix, Marseilles, and the neighbourhood. They are transported by land carriage in carts.

These coals easily pulverize. They must not be long left exposed to the air. When they have been totally reduced to dust by the action of the atmosphere, or the effect of carriage, they lose almost entirely their combustible property.

The very high price of wood in this country ought to produce much greater care in the working of these coal mines. It is probable that better products would be obtained; and even in case the lower strata should not present coal of the best quality, the longer continuance of the extraction might be ensured.

Subterranean fires have already destroyed a part of the strata of the coals of this country, and particularly at a place called la Galere; at another mine not far distant the strata took fire, and have been burning for several years.

Department of Calvados.

A coal mine (11) is worked in the commune of Litry, in the canton of Baynes. It furnishes from four to five millions of myriagrammes of coal of the best quality, the greater part of which is consumed in the country. A considerable quantity, however, is exported by the port of Isigny; and this mine, during the war, was a valuable resource to the ports of Cherbourg, Havre, and Honfleur at the mouth of the Seine; and for the manufactories of arms which were put in a state of activity at Saint-Valery-sur-Somme. The price of coals at the mine varies from 12 to 25 cents, according to its quality.

Great praise is due to the renters of the mine of Litry, who use every exertion to give proper activity to this enterprise. In the year 9 they erected there a steam-engine, which exhausts the water and at the same time draws up the coals. This machine was constructed by C. Perrier. It answers the purpose exceedingly well. It saves at this mine eighteen horses daily; and consumes about 50 myriagrammes of coals. It is much to be wished that the useful example set by the renters of the mine of Litry were imitated in other enterprises of a similar kind. I have been assured that the renters of the mines of Anzin, in the department of the North, are going to erect similar engines at their works.

The coal mine of Litry is the only one now worked in the department of Calvados. Searches have been made in several places,

places, but hitherto without fuccefs. From the report of C. Duhamel, infpector of the mines, it however appears that thofe begun at Feuguerolles, at a fmall diftance from Caen, deferve to be profecuted.

Department of Cantal.

This department (12), fo interefting to natural hiftory, and in particular on account of the antient volcanoes found in it, is not abundant in coal mines. It is only in the north-weft, in the diftrict comprehended between Mauriac and Bort, that fome collections of this combuftible are difcovered.

It appears that the fmall quantity of pits dug are only at the furface, and have been dug in a very irregular manner. We have no accurate information in regard to the quantity of coals extracted, or to the price. Thefe mines, however, which are not far from the courfe of the Dordogne, and from the place where that river is navigable for boats, might by thefe means obtain a very extenfive confumption, and deferve to be worked with greater care.

Departments of Charente and Lower Charente.

There are no coal mines worked in thefe two departments, and therefore they are obliged to procure their fuel from others. The ports of Rochelle and Rochefort may receive and give circulation to the coals carried thither by fea from the departments of the North or from England, or thofe conveyed by the internal navigation, and which might be fent to La Gironde by the Tarn, the Lot, and La Dordogne.

Department of the Cher.

No coal mines are worked in this department; but it might be fupplied in abundance with coals of an excellent quality by the Cher, if that river were rendered navigable with more fafety to above Saint-Amand, which would require very little expenfe. The rich collections of coal of Commentry, and the other ftrata lately difcovered in the environs of Meaulne, in the department of Allier, would obtain a confumption, which is at prefent wanting; and the working of them would give life to thefe cantons, and would concur with the products of the valuable forges in the department of Cher to increafe the means of induftry in that country.

Department of Correze.

Coals are dug up in feveral communes of this department (13), and a great many indications of this combuftible are found in it. The communes where the beft known mines are

now worked are Argental, where it appears there are abundant collections of coal; La Pleau, where several strata are known, and worked with facility, because they form part of a mountain in which galleries for extracting the coals, and suffering the water to run off, are constructed at a small expense: in a word, the communes of the Cublac, Ventessac, and the environs of Alassac.

The annual product of these different mines may be estimated at 50,000 myriagrammes. That of La Pleau supplies the manufactory of arms at Tulles, it affords the principal consumption; and that of Montignac supplies the manufactory of Bergerac.

The Vézère, which begins to be navigable at Uzerche, and La Corréze at Tulles, furnish some means of transportation for the other mines. The Dordogne, which is navigable for boats only at Souillac, would furnish more means of activity to the mines of La Pleau, and those of Argental, were it rendered navigable as far as the latter.

The mean price of the coals is 10 cents per myriagramme. The mines in general are badly worked, as they want a sufficient consumption.

Corsica and the Island of Elba.

The information hitherto obtained in regard to the mineral productions of these two islands does not afford reason to think that they contain coals.

[To be continued.]

XXIX. *Sketch of the General History of Mining.*

SIR, *To Mr. Tilloch.*

I AM happy in having it in my power to add to the Sketch of the History of Mining in Devon and Cornwall, with which I some time since troubled you *, a more extended view of the subject from the hands of an ingenious friend. If the insertion of either the former or the present in your valuable work shall ever draw to the subject the attention of those who are able, in different districts, to enlarge our knowledge on this head, it may be a general benefit, and will gratify

Your obedient servant,

JOHN TAYLOR.

Tavistock,
March 1803.

* See vol. v. p. 357—365.

Sketch

Sketch of the General History of Mining.

Conamur tenues grandia! HORACE.

IT gratifies the curiosity, and proves sufficiently amusing, to trace the origin and delineate the progress of any thing which occupies our thoughts or engages our attention; but when such an inquiry is connected with any important art or science, it surely must be more worthy the prosecution, as being calculated to afford some useful information as well as agreeable entertainment. Such are the effects that seem likely to result from the history of the rise and progress of the art of mining; and it is hoped that the reader may meet at least with the latter of these effects in this humble attempt to collect into a short compass what may perhaps convey some general idea of the antiquity of the art of working mines, and its gradual advancement to its present dignified and important station.

When we consider the many improvements and important discoveries that have been made in chemistry within these few years, and compare the increase of chemical knowledge in the present age with that of former periods, it may perhaps be thought that we cannot receive any advantages from old authors, and that histories of this kind scarcely deserve notice, because they are not absolutely necessary to the knowledge of mining, nor to the just performance of the several operations belonging to it. Yet, as nothing is more interesting to an artist than the rise and fate of his art, and nothing more useful to him than the labours and experience of his predecessors, it appears incumbent upon us to receive with acknowledgment, and study with attention, the works of those wise and enlightened men in the middle ages who directed their attention to the improvement of the arts, and, being free from the prejudices of hostile sects and attached to the love of truth, contemplated with steady zeal the operations and productions of nature, and described appearances as they existed, without any mixture of theory or hypothesis.

The art of discovering metals in the mine, and rendering them fit for use by chemical processes, is of the most remote antiquity. Moses, the oldest of all authors, mentions the use of brass and iron, which could only have arisen from some acquaintance with the metallurgic art; and this account is confirmed by the most antient historians and fabulists. Diodorus Siculus relates that the Egyptians adored Vulcan as a god, and esteemed him the first inventor of all arts and operations relating to metals; and all the profane authors coin-

cide in this belief of Vulcan being the firſt inventor of the uſe of metals, and that in the earlieſt ages of the world. Greece, the firſt enlightened nation of Europe, received the rudiments of her arts and knowledge from Aſia and Egypt, and probably tranſmitted her knowledge of working mines to the Romans. The antient Greeks and Romans were not deficient in the mathematical parts of mining, as ſome of their ſubterraneous works ſtill remain objects of admiration; and we may conclude from their accounts that they were good metallurgiſts and ſmelters, though they have left but few traditional practices and proceſſes, and theſe vague and not to be depended upon.

It ſeems probable that mines were objects of attention and inquiry among the Romans, as we find that the hiſtorian Tacitus, in his account of Germany, remarks that the inhabitants were not acquainted with their preſent valuable mines of gold, ſilver, &c.; but doubts whether treaſures might not be diſcovered upon ſearching for them. "Argentum et aurum propitii an irati Dei negaverint, dubito. Nec tamen affirmaverim nullam Germaniæ venam argentum aurumve gignere. Quis enim ſcrutatus eſt? Poſſeſſione et uſu haud perinde afficiuntur. (*De moribus German.*)

And it ſeems probable alſo that the Romans were acquainted with the proceſſes of digging, ſeparating, and purifying, metals; as the mines in Tranſylvania are generally ſuppoſed to be Roman works; and ſome mines on the Rhine and the Danube, in Lorrain, Alſace, Suevia, and Noricum, appear to have been worked in the decline of the antient Roman empire.

After the deſtruction of the weſtern empire, when all learning, books, arts, and ſciences, were overwhelmed in the general wreck, we have no account of any mineralogical purſuits until the middle of the tenth century, when the mines in the Rammelſburg, near Goſlar, and ſome of the adjacent ones in the Hartz mountains were diſcovered, and worked to advantage. The metallurgical proceſſes at Goſlar were probably conducted upon traditional proceſſes either Roman or German; and we may ſuppoſe the knowledge of the Germans was not conſiderable if we judge from their operations, which, on account of the irony and zincous refractory mixtures, were various, compound, and tedious. The commencement of the ſixteenth century may be looked upon as one of the moſt remarkable and ſplendid epochs in the annals of mining, as well as in the annals of the world. Arts and ſciences then began to be proſecuted with ardour and ſucceſs, and from this æra the productions of nature were ſtudied and unfolded

to

to man. The traditional and empirical science of metals now gave way to the scientifical principles of chemistry, which were derived from the Arabians.

Agricola was the first of the learned writers on this subject; and for his extraordinary learning and practical erudition in his treatises *De Re Metallicâ et de Re Fossilium* he is justly entitled to the first place among the chemical metallurgists who have since appeared. H. R.

XXX. *On the Conversion of Grass Land into Tillage, &c.**

To the Editor of the Philosophical Magazine.

SIR,

WITHOUT offering you any apology for intruding upon your time, I take the liberty of sending you an abstract of a paper to which the utmost consequence is attached from its subject, and written by a man whose name is too well known amongst those skilled in agriculture to need any commendation.

The essay is divided into three chapters, and each chapter is divided into sections. The present communication is an abstract of the first chapter.

Mr. Close sets out in this chapter by saying (which is an undoubted truth) that agriculture is the parent of commerce, but that it has made a very slow progress, considering its utility and the advantages we derive from such a beautiful science. The obstacles which are supposed (and justly too, I firmly believe) by Mr. Close to the improvement of agriculture, are tithes: the difficulty and expense of inclosing waste lands: expensive and injudicious leases: want of knowledge in the practical farmers: the great increase of the poor-rates; and a want of that energy which formerly characterized the agricultural labours of this island.

Mr. Close conceives it would be much more to the advantage of the farmer, and not in the least injurious to the clergy, if some mode of paying the latter were devised instead of taking their income as it is done at present, which is one great check to the improvement of agriculture.

The tithes should be valued throughout the kingdom by some able person or persons, and, after a proper valuation has been

* From a paper on the subject by the Rev. H. Close, of Hordle, near Lymington; published in the Communications to the Board of Agriculture, vol. iii. part 1.

been ſet upon them, to be offered to the owner at that valuation *. When the tithes are ſold, the money ſhould be inveſted in the funds; and Mr. Cloſe calculates, that half, or at moſt three-fourths, of the intereſt ariſing from this capital would pay the clergy their preſent incomes, and the ſurplus to accumulate for their benefit ſhould proviſions, &c. advance. In order that the annuitants ſhould receive an adequate compenſation if any ſuch advance took place, the average price of wheat ſhould be taken once in four or five years, and a proportionate addition be made to their incomes as the corn had advanced. This meaſure is propoſed by Mr. Cole to originate with the crown. He calculates that the livings now in the patronage of his majeſty amount to about 110,000 l. per annum, to which ſhould be added at leaſt one-third to make their full value, which would come to about 146,000 l. per annum. If theſe tithes were ſold at only twenty-ſix years purchaſe, it would produce a capital of 3,796,000 l., which, at only four per cent., would ſecure to the clergy holding ſuch preferment their full income, and leave above 40,000 l. a year to accumulate for their benefit ſhould any unforeſeen accident ariſe. By this ſcheme, neither his majeſty nor any other patron of a living would be deprived of their patronage.

To obviate the difficulties attending an incloſure of waſte land, Mr. Cloſe propoſes, inſtead of a bill being brought into parliament, that there ſhould be an act "to empower the magiſtrates at quarter ſeſſions to judge of the expediency or inexpediency of ſuch incloſure," and that the uſual notices ſhould be given of ſuch a meaſure in the county papers, &c.—The bench of magiſtrates ſhould appoint five acting magiſtrates who are entirely diſintereſted in the incloſure; theſe five to appoint two commiſſioners, who ſhall be ſworn to do juſtice to all parties in adjudging the claims. Theſe commiſſioners ſhould have a certain ſum (firſt agreed upon) paid them, and by no means to be paid by the day or mile; and not to act upon more than one incloſure at the ſame time. Should any diſpute ariſe, the magiſtrates to decide, and the party againſt whom ſuch a deciſion is made, to pay all coſts †. Mr. Cole obſerves, that as this is empowering the

* There are few proprietors, I believe, in this country, from all I am able to learn, who would not jump at ſuch a propoſal, were the tithes valued at a price worth his attention.

† It is with great deference I beg leave to differ with Mr. Cloſe reſpecting his mode of deciding diſputes by magiſtrates: however impartial they are ſuppoſed to be, and whatever may be the opinion of the "higheſt legal authority," it is putting the property of individuals into the power of

the magiſtrates to decide upon law and fact, he would recommend that a ſtatement be made for the opinion of the "higheſt legal authority." No right ſhould be preſerved to render this incloſure null and void; and ſhould any portion of land be allotted to a perſon who is the oſtenſible owner of the eſtate, and ſhould afterwards be evicted, the common then to be given to the owner. Mr. Cole believes that there is great want of ſkill, and not, as many ſuppoſe, capital.

Of leaſes, the following ſketch he recommends *:—The landlord covenants to give quiet poſſeſſion of the houſe and out-houſes, and to put and keep the ſame in repair; alſo to put the gates, ſtiles, and every ſort of fence in repair; to inſure quiet poſſeſſion of the above, and of ——— number of acres of lands ſituated in the pariſh of ———, for ——— number of years; to pay the land-tax, and allow the tenant to hold certain part of the buildings and lands for a ſpecified term after the expiration of his leaſe. The tenant covenants to take the premiſes, to pay his rent in two equal half-yearly payments; to cart all materials for repairs gratis; to find the workmen, when employed in ſuch repairs, the uſual allowance of wholeſome beer; to keep and leave the gates, poſts, rails, and every ſort of fence in repair; to allow the landlord or his agents free ingreſs and regreſs to ſhoot, fiſh, or hunt, over the lands; to warn off every one, and to bring actions, if neceſſary, at the landlord's expenſe, againſt all perſons who may treſpaſs upon the premiſes; not to break up certain portions of meadow and paſture lands; to keep the ditches and water courſes open; to crop the lands according to the rotation recommended in the table at the end of this eſſay †, having reſpect to the different ſoils: to pay all parochial taxes; to expend the hay, ſtraw, haulm, and other fodder, produced from the lands, upon the premiſes; and to uſe all the dung, ſoil, and compoſt, ariſing from the ſame, upon the ſame lands belonging to the premiſes hereby demiſed; except the produce of ſuch dung and compoſt, &c. ariſing from the two laſt years' crops previous to the expiration of the leaſe; all of which ſhall be left, in a farmer-like manner, in the farm-yards, or other convenient place, for the uſe of

of a ſet of men whom the old common law of England did never authorize to decide upon ſuch queſtions, and wreſting that invaluable bulwark of our liberties, *the trial by jury*, from our hands, which the conſtitution does authorize to determine. This bleſſing is too much curtailed already, and I truſt we ſhall never ſee it laid aſide upon ſuch an important caſe as the one in queſtion.

* This ſketch appeared to me ſo important, that I thought it would be better to give it complete, inſtead of abridging it.

† This will be given in a ſubſequent paper.

of the landlord or in-coming tenant: to leave all the ſtraw of the laſt year's crop to the in-coming tenant, he carting the corn to any market within the diſtance of ten miles*; to pay five pounds an acre additional rent for every acre of meadow or paſture land, ſpecified as not to be broken up, ſhould he plough or till the ſame; to pay five pounds an acre additional rent for every acre cropped contrary to covenant; to preſerve timbers; not to cut, lop, or top, any pollard trees, underwoods, or hedge rows, under eight or ten years growth, according to the productiveneſs or ſterility of the ſoil: to allow landlord or his agents to cut or fell timber, and to cart the ſame off the land, at ſeaſonable times.

For the want of knowledge amongſt practical farmers, which Mr. Cole thinks very great, he propoſes that an experimental farm ſhould be taken by the Board of Agriculture, and to allow a certain number of pupils, on paying a certain ſum of money, to be inſtructed in every branch of agriculture, and alſo thoſe ſciences more immediately connected with it. This farm to be ſupplied with proper perſons as inſtructors, and particular rules for the conduct of the pupils to be laid down and ſtrictly obſerved. There is a great want of communication (obſerves Mr. Cole) with reſpect to approved facts in agriculture; and being generally known in Norfolk and Suffolk, he propoſes that noblemen and gentlemen ſhould take a proper perſon as a tenant from either of theſe counties, and place them upon a centrical part of their eſtates, lying in a county where the management and improvement of graſs lands and ſtock are well underſtood. He then gives his opinion from what part of Suffolk or Norfolk theſe men ſhould be taken, according to the nature of the land upon which they are to be placed.

The poor rates juſtly come under Mr. Cloſe's cenſure. He conceives that the enormous rates lately levied are owing to the inadequate price of labour in proportion to the price of proviſions †. This not only burthens the farmer with a conſtant

* This clauſe not to extend to dairy farms; as, where a large ſtock is kept, the out-going tenant ſhould have permiſſion to fodder his cattle with it until the ſpring, leaving the dung, &c.—*Note by Mr. Cloſe.*

† The following curious circumſtance deſerves to be mentioned:—When the miniſters and their friends in the houſe of commons were propoſing ſubſtitutes for bread, and bounties upon different articles, Mr. Horne Tooke, in one of the debates upon a potatoe bill, threw out to the houſe this very idea of the price of labour being inadequate to the price of proviſions, and that the poor man's one pound was not worth one-fourth to him now, when compared with its former value: he recommended to miniſters to drop this method of relieving them, as it never would anſwer, for

ſtant load upon his operations, but falls extremely heavy upon the poor mechanic, whoſe profeſſion will not permit him to make that advance on his articles the heavy taxes he pays would juſtify him in doing. It likewiſe ultimately falls upon the land owner, who, when he lets his farm, the valuation is always taken according to taxes, rates, &c., which the farm pays, and of courſe a deduction is made in favour of the tenant. It has likewiſe deſtroyed a very valuable claſs of ſociety, viz. the induſtrious and labouring people, whoſe honeſt pride was to boaſt that they never were beholden to their pariſh for aſſiſtance. The plan of relieving theſe induſtrious people is likewiſe bad; not that it can be altered, but by aſcertaining what a man earns, and paying him accordingly: he who is ſtrong and able, and gets a tolerable maintenance, ſeeing the man who is not able, by reaſon of his weakneſs or ill health, receive more, thinks that by ſlackening his work he ſhall receive more; and this is abſolutely the caſe almoſt every where: and he adds, "I am fully perſuaded, that by the aggregate body of agricultural labourers not more than three-fourths of the ſame work is performed as was done ten years back by the ſame number of hands." Mr. Cloſe then goes on to propoſe a plan for the relief of what is called "ſecond poor;" viz. thoſe labourers who have never received pariſh relief, but are entitled to a relief from charities left to pariſhes. As there are but few who have not had pariſh relief, and conſequently not entitled to theſe charities, an act of parliament ſhould be paſſed entitling this claſs of people to theſe charities, notwithſtanding having received pariſh relief. To guard againſt this valuable part of the community being again degraded, he propoſes that "the price of labour ſhould be regulated by the price of bread corn." Mr. Cloſe alſo propoſes that thoſe who do receive pariſh relief after ſuch a regulation as this, ſhould be badged *.

I am, Sir,

Your very obedient ſervant,

AGRICOLA.

for they only increaſed the price inſtead of lowering it. They ſaw the wiſdom of this remark, and they never propoſed any more bounties to lower the price of proviſions.

* Here too, again, I beg leave to differ from Mr. Cloſe with reſpect to *badging* the poor. It is making a diſtinction to which the loweſt of mankind only will ſubmit, and making a diſtinction to a claſs of people who probably may be obliged to ſeek parochial relief owing to misfortunes, and not to dearneſs of proviſions.

XXXI. *Hiſtory*

XXXI. *History of Astronomy for the Year* 1802. *Read in the Athenæum of Paris December* 30, *by* JEROME LALANDE.

IF we were astonished last year to see the History of Astronomy begin with the discovery of a ninth planet, we ought to be much more so to find this year also a discovery of the like kind, which we did not expect. It was also by a fortunate chance that the tenth planet was found; but it was necessary that chance should favour an assiduous and intelligent astronomer.

At nine in the evening on the 28th of March 1802, Dr. Olbers observed at Bremen Piazzi's planet, which had afforded occupation to astronomers for a year. He was examining with his telescope all the small stars in the Virgin's wing to ascertain their positions; and that he might be enabled to determine with more ease the places of the planet, he had arrived at the twentieth star of Virgo, near which he had observed the planet in the month of January, and was surprised to see near this star, which is of the sixth magnitude, another small one of the seventh. He was certain that it had not been there at the time of his first observations: he therefore hastened to determine its position; and having continued to view it for two hours, he perceived that in this interval it had changed its position. The two following nights afforded him the means of determining its motion, which was 10′ per day. As soon as he had made public this curious observation, astronomers took the earliest opportunity of observing this new star, and of calculating its orbit. Dr. Gauss, an able geometrician of Brunswick, calculated the elements, and C. Burckhardt employed himself on similar calculations.

On the 4th of June C. Burckhardt finished his calculations in regard to this star of Olbers. We expected them with great impatience, being desirous to know whether it was a planet or a comet. He found its revolution to be 4 years 7 months and 27 days; its distance 2·785, or 96 millions of leagues; its eccentricity 0·2463, which produces an inequality of 28° 25′; its inclination 34° 51′; its node 5^s 22° 28′; its aphelion 10^s 2° 3′; and the epoch of its longitude for 1802 4^s 23° 10′.

On the 14th of November C. Burckhardt published others in the Moniteur, which correspond to the observations made as far as the 20th of September 1802. The revolution 4 years 7 months 13 days; distance 2·7699; eccentricity 0·2463; inclination 34° 38′ 0″; node 5^s 22° 27′ 35″; aphelion 10^s

$1^s\ 12'\ 19''$; epoch of 1802, $4^s\ 23°\ 21'\ 38''$, the 31st of December preceding; equation 28° 25′. C. Burckhardt has calculated also the perturbations of Olbers's planet, which amount to several degrees; they are long and difficult, and will require changes in the foregoing elements. Dr. Gauss has published in Von Zach's journal for September an ephemeris of Olbers's planet up to the 1st of July 1803. But C. Burckhardt, when he has finished his calculation of the perturbations, will give us elements still more certain.

In the beginning of January Dr. Olbers found again Piazzi's planet, which had disappeared for a long time; and astronomers continued to observe it till the month of July. After the 15th of February Dr. Gauss calculated the new elements; but C. Burckhardt undertook to calculate the perturbations which that planet experiences by the attraction of Jupiter, and found more exact elements. We afterwards received the perturbations calculated by M. Oriani of Milan, and which Dr. Gauss took into account that he might better obtain the elements of its orbit. Those given in Von Zach's journal for the month of November; distance 2·7675; tropical revolution 1681 days 9 hours; eccentricity 0·078835; equation 9° 2′; inclination 10° 57′ 37″; epoch for 1803 at Gotha, 233° 37′ 35″; aphelion 326° 37′ 40″; node 80° 35′ 1″.

The king of Naples has made an addition of 1200 francs to Piazzi's salary, in consequence of his discovery of the new planet, and the homage he has rendered to his majesty by naming it in his writings *Ceres Ferdinandea*.

This year we have had also a comet, and though very small it was discovered in three places: at Marseilles, on the 24th of August, by Louis Pons, keeper of the observatory; on the 28th, by C. Mechain, one of our most celebrated astronomers, to whom we are already indebted for a great number; at Bremen, on September 2d, by Dr. Olbers, who discovered the tenth planet. This comet was in Serpentarius, very faint and ill defined, having a very sensible nucleus.

C. Mechain and C. Messier at Paris, and C. Vidal at Mirepoix, observed it with care till the 3d of October; and C. Mechain calculated its elements in the following manner from his own observations: Node $10^s\ 10°\ 17'$; inclination 57° 0′; perihelion $11^s\ 2°\ 8'$; distance 1·0942; passage of the perihelion, September 9th, $20^h\ 43'\ 15''$ direct motion. The elements calculated by Dr. Olbers, as well as his observations, have been inserted in Von Zach's journal.

It may here be seen that this comet is among the small number of those which at their greatest proximity to the sun are

are further distant than the earth: it is the 93d the orbits of which are known.

C. Lalande junior has had the satisfaction of furnishing exact positions of stars, before unknown, with which astronomers had often been obliged to compare this comet; and the same thing has happened to him these fifteen years.

The new tables of the moon by M. Burg form a very important epoch in the history of astronomy for this year. I was informed by Dr. Von Zach that M. Burg had been employed at Vienna, amidst poverty and obscurity, in calculating observations of the moon made at Greenwich, with the hope of improving the tables of the moon: and on the 19th of March 1798 the commissioners of the Institute, being assembled at the Board of Longitude to determine on the subject for a prize, I proposed to them to require the establishment of the epochs of the moon by a great number of observations. I knew that M. Burg had calculated a great many, and I judged that this would give him an opportunity of publishing them, and at the same time afford us the means of rewarding his labour. When the prize came to be adjudged, as C. Bouvard made a great many interesting researches also, it was thought proper to divide it. But general Bonaparte, who that day presided, proposed to double the prize, in order that each might have 3400 francs: and this was agreed to.

C. Laplace, finding that this sum was too small for so immense a labour as that of C. Burg, and that he could deduce from these calculations all the moon's equations with a precision never before obtained, induced the Board of Longitude to propose a prize of 6000 francs, and prevailed on the minister of the marine and of the interior to furnish each the half of this sum. The question was published on the 20th of June 1800, and by the commencement of November 1801 we received the tables so much wished for; and then several supplements. On the 26th of January C. Laplace announced to the Institute, that he had found in the theory of the moon an equation the period of which is 180 years, and which amounts to 16″; so that it will serve to explain the disagreement observed between the mean motion of the moon 100 years ago and that given by the last observations. This equation is composed of two terms, of which, for the moment, we can have only the sum; but it has served to establish in the motion of the moon, at different periods, a regularity which before could not be obtained.

On the 25th of July a deputation from the Board of Longitude went to give in its report to the first consul on the labours of Burg, and the prize of 6000 francs. I reminded

him, that he had caused the first prize to be doubled, and that it would be worthy of his character to double the present one. He instantly complied. The minister Chaptal, who was present, proposed to me to induce Burg to come to Paris, where he should have a pension of 3000 francs. He would be an excellent co-operator in improving astronomy in France, where it is already so much cultivated: but this worthy astronomer preferred his own country with less advantage. His tables of the moon are about to be printed, as well as the new tables of the sun by Delambre; and we have already communicated them to Dr. Maskelyne, the astronomer royal of England, who will be enabled by them to improve the Nautical Almanac, which since 1767 has been of the greatest utility to navigators.

The report of C. Delambre will be published in the *Connoissance des Temps* for the year 13, which is about to appear.

The Arabic text of all the observations in the manuscript of Ibn Junis, lent to us by the Batavian republic, with a translation by C. Caussin, and an extract from the part which it was not judged necessary to translate and to print, has been finished at the printing-office of the republic. C. Caussin is the first of all the professors of Arabic who has rendered his knowledge really useful. I reproached them fifty years ago, on account of their translating nothing but romances.

The observation of the eighteenth transit of Mercury over the sun's disc on the morning of November 9 perfectly succeeded. We were the more interested in it, as it will not be again seen at Paris till the 5th of May 1832. It confirmed, in the completest manner, the exactness of my tables of Mercury. The egress of the centre, according to a mean of all the observations, took place at 7′ 34″ afternoon; and the longitude of Mercury which I thence deduced is $7^s\ 16^\circ\ 17'\ 9''$, at $21^h\ 2'\ 40''$ mean time of the conjunction, even taking into account the correction to be made in the tables of the sun, which by my nephew Lalande was observed to be — $10''4$; the geocentric latitude in conjunction $56''$. I have had the most satisfactory confirmation of the theory of Mercury, which I gave in the first memoir, read in the first sitting of the first class of the Institute on the 1st of January 1796. More details on this subject will be found in the Memoirs of the Institute.

M. Casella, physician to the king of Naples, and M. Bygge, astronomer royal of Copenhagen, &c. have sent me exact observations of this transit.

The solstice was exactly observed with whole circles by C. Delambre, and by C. Burckhardt and Lalande junior. The

The mean of four hundred obfervations gives 23° 28′ 7″, or 7″ more than in my tables: laft year it was only 6″; we ought to be fatisfied with this agreement.

Duc-la-Chapelle has publifhed, in the fourth volume of the Memoirs of the Inftitute, folftitial obfervations which give him 31″ for the fecular diminution of the obliquity of the ecliptic. C. Mechain has ftill found 10 feconds lefs for the obliquity of the winter folftice.

C. Vidal has fent in his obfervations of the new planets and a great many others: he has even had the complaifance to terminate fome zones of circumpolar ftars which were not complete in the *Hiftoire Celefte Françoife* publifhed in 1801.

The inferior conjunction of Venus, obferved in the end of December by C. Burckhardt and Lalande, gave us for the correction of my tables + 29′, which do not make 10 in the longitude feen from the fun.

But as the tables of Venus had not yet been calculated with the perturbations, and as C. Lalande junior propofed to undertake this labour, C. Chabrol furnifhed him with a table of the equation calculated to tenths of feconds, which was an effential preliminary. It is time it fhould be begun. We have 40 years exact obfervations of Venus; and thefe 40 years obfervations, from 1761 to 1801, will give us the motion of Venus as exact as the Babylonian obfervation made 2072 years ago, and refpecting which there is fome doubt, as I have already explained. (See *Mémoires de l'Academie* 1785, p. 250.)

The oppofition of Mars, which took place on the 24th of December, could not be obferved; but the obfervations of that night gave a correction in the tables of Lalande junior − 5″; which make only two in the heliocentric longitude.

The difappearance of Saturn's ring, which will take place in 1803, has been preceded by a fingular phænomenon. The *anfes* were on the point of difappearing, and it was with difficulty that C. Mechain difcovered them on the morning of December 20. C. Flaguergues alfo loft fight of them on the 16th. But we fhall foon fee them re-appear, as the earth will return on the 28th of June: the fun paffing through the plane of the ring, we fhall lofe fight of them till the 23d of Auguft, at which time the earth will pafs to the north of the ring, and permit us to fee the furface of it illuminated by the fun. *Dufejour, Traité analytique des Mouvemens Celeftes*, vol. ii. p. 155.

C. Chabrol and C. Flaguergues have calculated a great number of tables of aberrations and nutations for 600 ftars of the fundamental catalogue which Lalande junior inferts every

every year in the *Connoissance des Temps*, and always with new improvements.

C. Lalande, my nephew, continues to observe the right ascensions and declination of a great number of stars not well known; and madame de Lalande continues the reductions, which she promised, for the 50,000 stars: 1500 will be found in the *Connoissance des Temps* for the year 13, which will soon appear; and M. Bode has published more than 10,000 in the catalogue of 17,000 stars which accompany the large and beautiful atlas in twenty sheets which I have already announced.

Last year I gave an account of the labour undertaken by the Swedish astronomers Svanberg, Osverbom, Olmquist, and Palander, to verify the degree of the meridian under the polar circle. M. Melanderhielm, though 76 years of age, set on foot and directed this enterprise. In 1801 they had already discovered the stations, elevated the signals, and built two observatories. They set out in the month of January 1802, and measured the base on the ice of the river Torneo between the 6th of February and the 8th of April, though the cold was 24°. At the beginning of September they had completed the measurement of the angles of their triangles, and set out to proceed northwards to Pathavara to commence their astronomical observations. We shall therefore soon have the curious result of this new measurement.

On the other hand, C. Mechain, in consequence of the consular decree of September 17, is about to resume the measurement of the meridian as far as the island of Cabrera, which is 40 leagues south of Barcelona, agreeably to his wish, which I announced in the *Connoissance des Temps* for the year 10. By these means the 45th degree, which it is particularly interesting for us to be well acquainted with, will be a mean of the whole interval.

The Portuguese, whose silence we regretted, begin to distinguish themselves. M. Demonfort has sent us calculations of eclipses of the sun visible at Lisbon during this century: M. Monteira de Rocha, new tables of Mars, with all the perturbations. The equation is 10° 41′ 39″, greater only by 4″ than in the tables of C. Lalande junior. M. Damoiseau, captain-lieutenant of the royal brigade of the marine at Lisbon, has written to me that he is employed on the Nautical Ephemerides of 1806. Those of 1805 were calculated directly, without employing the Nautical Almanac. I have requested him to wait for the new tables of the sun and moon, which are about to be printed.

We have received also a description of the observatory of Coimbra,

Coimbra, from which it appears that it is pretty well furnished with instruments: a sector of 10 feet, a 5-feet meridian telescope, a 3½-feet quadrant divided by Troughton of London.

We have received the Astronomical Ephemerides of father Cossali, of Parma: they are not destined for astronomers such as those of Berlin, Vienna, Milan, Bologna, and Paris; but the author has added a very minute history of the two new planets, and he follows my example in giving them the names of Piazzi and Olbers; he also employs that of Herschel, as a mark of homage due to them by astronomers.

On the 22d of June 1802, M. Van Swinden sent us a Dutch memoir on the new measures, which engaged him a long time; and he has obtained a decree for establishing the new measures in the Batavian republic.

Mr. Mackay has published a curious work, in England, on the longitude.

M. Van Swinden has sent us the fourth edition of his Dissertation, in Dutch, on the Determination of the Longitude by the Observation of the Moon's Distance from the Stars; with a dissertation, which he published in 1788 conjointly with M. Nieuwland, on the Use of Sextants and Octants. He proposes to publish also a memoir on reflecting circles, which he wishes to introduce into the Dutch navy; and also on marine time-keepers. So early as the year 1774 I went to Holland to solicit the introduction of astronomy into navigation, and obtained a promise for that purpose from the stadtholder and the grand pensionary. My Astronomy was even translated into Dutch: but this circumstance was attended with little advantage at that time, notwithstanding the need which navigators had of it. At present, since the navy resumes new activity in the Batavian republic, and that the learned professor enjoys there a well merited influence, we have reason to believe that astronomy will be employed there in an effectual manner.

M. Van Swinden explains in this work all the methods, by calculation, by graphic operations, and by instruments; the corrections made by Mr. Mackay to the methods of Borda and Dunthorn; those of Kraft and of Douwes de Steinstra. He has added a collection of such tables as are necessary in navigation.

M. Mendoza has already published two large collections of tables for navigation: he has added a new method of determining the latitude by two altitudes taken out of the meridian, the calculation of which is shorter than the first approximation, which is only the commencement of the method of Douwes.

We

We have received the Ephemerides of Vienna for 1803, which contains the new tables of the moon by M. Triesnecker; but it is evident that he has seen those of M. Burg already mentioned: also the Ephemerides of Berlin for 1805, where M. Bode has collected 170 pages of observations on the new planets, and on other important points in all parts of Germany.

M. Schroeter has published a continuation of his observations on the spots of the moon, in a large volume in quarto, entitled *Selenotopographische Fragmente*; that is to say, Topographical Fragments respecting the Moon: to serve for giving a correct idea of the surface of that luminary, and the changes which have taken place in it, in its atmosphere and in its mountains; by Dr. F. F. Schroeter, grand bailiff of Lilienthal, near Bremen. Part ii. 1802. pp. 565. 4to. with 32 plates. Göttingen.

The first part appeared in 1791: we published two extracts from it, which show with what patience and minuteness this able astronomer has examined the surface of the moon.

These new observations were made with the same care for twelve years, and with optical instruments of the greatest power, (two telescopes, one of 13 and the other of 27 feet.) They entitle him to the gratitude of astronomers, as they will serve them as a base and term of comparison in their future researches respecting the changes that may take place at the surface of the moon. He has observed mountains which rise to the height of 4000 toises, and others to the height of 2400. M. Schroeter has also determined, that the part of the lunar atmosphere which is sufficiently dense to produce the crepuscula, is 300 toises in height.

The author has also seen objects which he did not see in the course of his preceding observations, and which on the first view might be ascribed to changes that have taken place at the surface of the moon: but he remarks, with the reserve of an able observer, that the particular state of the lunar atmosphere may have concealed these objects at the time of his first observations.

Dr. Henzenberg, of Hamburgh, between the months of July and October 1802, made thirty-one experiments on the fall of bodies from the steeple of St. Michael, which is 235 Paris feet in height: and found that heavy bodies do not fall vertically; there are four lines of declination towards the east, and 1·5 line towards the south.

M. Guglielmini, of Bologna, found a little more. But all these experiments tend to prove the rotation of the earth.

[To be continued.]

XXXII. *Notices respecting New Books.*

Elements of Chemiſtry. *By* JOSEPH FRANCIS JACQUIN. Tranſlated from the German. 8vo.

A SECOND edition of this work has made its appearance; a proof of the favourable reception it has experienced from the public. We have no heſitation in ſaying that it is a uſeful work, and ought to make a part of every chemical library. The language poſſeſſes that preciſion which conſtitutes the chief merit of a tranſlation, eſpecially from a ſcientific or practical work. It is by Mr. Stutzer.

A Syſtem of Chemiſtry. *By* THOMAS THOMSON, *M.D.* 4 Vols. 8vo. 1802.

The taſk of compoſing elementary treatiſes, as the author juſtly obſerves, has in this country been uſually left to men of inferior endowments, as a piece of drudgery below the dignity of a philoſopher; while in France, excellent ſyſtematic treatiſes have appeared on almoſt every part of ſcience by men of the firſt abilities. Though we can rank ſeveral diſtinguiſhed names among our authors of elementary works, it is certain that "we have more frequently satisfied ourſelves with tranſlating the ſyſtematic works of foreigners, even when the diſcoveries of our own philoſophers had furniſhed a conſiderable portion of the materials of theſe works. The conſequence has been, what was naturally to be expected, the labours of our philoſophers have been frequently overlooked, and their diſcoveries claimed by others to whom they did not belong; while theſe claims, conſtantly inculcated in all the elementary treatiſes of chemiſtry, have been received as firſt principles by the greater number of readers. It is incontrovertible, that, for the rapid progreſs which chemiſtry has lately made, the ſcience is deeply indebted to the philoſophers of this country. Much, indeed, has been done by the illuſtrious body of French chemiſts; but theſe gentlemen, not ſatisfied with a part, have laid claim to the whole."

The author ſtates his work to have for its object the giving a full detail of the vaſt number of facts which conſtitute chemiſtry, blended with the hiſtory of their gradual development, and of the theories which have been founded on them, and accompanied with exact references to the original works in which the different diſcoveries have been regiſtered. It is but juſtice to ſay, that Dr. Thomſon has executed the taſk he has undertaken in a manner creditable to himſelf. His work preſents

presents a more complete and accurate collection of facts than any previous publication of the kind. The arrangement is judicious, the quotations are candid, the reasoning satisfactory and perspicuous. We have no hesitation in recommending it as a most valuable performance.

The Chemical Pocket-Book, or Memoranda Chemica; arranged in a Compendium of Chemistry. By JAMES PARKINSON. 12mo. 1803.

It gives us pleasure to announce that a third edition of this valuable little work has made its appearance, embracing all the new facts in chemistry that have been observed since the publication of the former editions. A considerable degree of care seems to have been bestowed upon it, and several new and useful tables have been added in different parts.

A System of Theoretical and Practical Chemistry, &c. By FREDERICK ACCUM, *Teacher of Practical Chemistry, Pharmacy, and Mineralogy; and Chemical Operator in the Royal Institution of Great Britain.* 2 Vols. 8vo. with Plates. 1803.

This work, just published, will prove highly acceptable to those who wish to attain a practical acquaintance with the science of which it treats. The author exhibits throughout the work a great degree of chemical knowledge; and his method of communicating knowledge to others is engaging. With the practical part of the various processes in chemistry he seems to be well acquainted; and the accuracy and precision with which he describes them, will render his work valuable not only to tyros, but to proficients in the science. Many of the experiments, some of which are calculated to afford both instruction and amusement, are quite new; and even in detailing experiments which are not new, particulars not to be met with elsewhere are often given, which will be useful to the practical chemist.

XXXIII. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

SINCE our last report several meetings have been employed in reading a paper on tanning, by Mr. Davy, professor of chemistry in the Royal Institution of Great Britain. In this paper the author not only describes the processes usual in the art of tanning, but enters into a chemical investigation of the

 nature

nature of the agents employed in the procefs, and details a number of ingenious experiments undertaken exprefsly for the purpofe of afcertaining the mode of their operation. The refults are interefting, and cannot fail to be ufeful to thofe engaged in the manufacture of leather.

ROYAL ACADEMY OF SCIENCES AT BERLIN.

On the 18th of January the academy held a public fitting to celebrate the anniverfary of its eftablifhment. It was opened by the director Merian with an oration; after which M. de Verdy du Vernois read the fketch of a plan for reviving the antient tournaments, and fhowed the utility of again introducing this antient amufement, formerly a fchool for dexterity and intrepidity, and which might be attended with great advantage to the cavalry fervice, and to all troops that fight on horfeback.

M. Erman then read a paper containing particulars refpecting the reign of the elector Frederic William the Great, extracted from a manufcript diary of marfhal Dieterich Sigifmund von Buch.

M. Klaproth next read a differtation on ftones and iron maffes, and fhowed that the fall of fuch bodies from the heavens is a phænomenon totally different from all the other phænomena of nature; and that it needs therefore excite no wonder that doubts have been entertained refpecting the truth of fuch facts, but that hitherto they are not only fupported by experience, but by chemical analyfes of the fallen bodies. As a contribution towards this fubject, M. Klaproth gave an account of experiments, made by himfelf, with fome of thefe productions which had fallen at different times and in different countries, particularly a fpecimen of that which fell near Siena on the 16th of January 1794; and a fragment of the mafs of iron, weighing 71 pounds, which fell near Agram on the 26th of May 1751, comparing them with the analyfes lately publifhed by Mr. Howard of the ftones which fell at Benares in the Eaft Indies on the 19th of December 1798, and on the 13th of December 1795 in Yorkfhire; and adding a fhort hiftory of thefe and fome other bodies that have fallen from the clouds. They confift either entirely of cellular maffes of iron, or of ftony fubftances mixed with grains of iron. In all of them the iron is of the fame nature: it is ductile, exceedingly tough, appears white when filed, and almoft always contains nickel. The ftones are covered on the outfide with a black cruft, are bright gray in the infide with black fpots, and interfperfed, befides the ferruginous particles, with grains of pyrites. The principal part of the mafs

mafs confifts of oxide of iron, magnefia, and filex. The opinion of Dr. Chladni, that thefe meteoric productions are fragments of fire-balls which have burft, may be confidered as fully eftablifhed. Real native iron from the mines of Kamsdorff is diftinguifhed from the meteoric iron by not containing any nickel, and by containing a mixture of copper-lead.

FRENCH NATIONAL INSTITUTE.

Account of the labours of the Mathematical and Phyfical Clafs during the firft quarter of the year 11.

MATHEMATICAL PART, read by C. Lacroix.

ASTRONOMY.

Obfervations on the Tranfit of Mercury over the Sun's Difc, November 9, 1802.

If the theory of attraction, aided by the powerful means of analyfis, has enabled aftronomers to give, almoft at once, to the tables of the planets, and particularly to thofe of the moon and fun, a degree of exactnefs far fuperior to that to which they could have been carried by the efforts of obfervers alone during a long feries of ages, time has not, on that account, loft its right to the perfection of thefe refults deduced from the meafurement of its duration. Aftronomers therefore, always attentive to the fpectacle of the heavens, never fuffer to efcape but with regret opportunities of obferving the fimpleft and moft frequent phænomena, becaufe they know that, however precife they may be for the moment at which they are affigned, aftronomical determinations have continual need of being rectified: with much more reafon, therefore, they are anxious to take advantage of thofe circumftances where the pofition of the planets is lefs affected by the combination of their own motion and that of the earth. Such in regard to Mercury are his tranfits over the difc of the fun.

The firft of thefe phænomena preferved in the annals of aftronomy was obferved in 1631, at the college of France, by Gaffendi, one of the moft illuftrious profeffors of that celebrated fchool. Since that time great attention has been paid to this phænomenon; and the obfervations of thefe tranfits, which follow each other pretty rapidly, have been multiplied. C. Lalande has employed himfelf in collecting and examining them with a care and affiduity for which he has been rewarded by the perfection he has thence been able to give to his tables of Mercury. After having fucceffively corrected each element, he waited for a confirmation of them by the

tranfit announced for the 9th of November 1802, and hoped he fhould then be able to be convinced that his tables, one of the moft important refults of his long labours, had reached the utmoft perfection to which they could attain in the prefent ftate of the fcience. His wifhes have been fully gratified by the obfervations we are about to detail.

The moments of interior and exterior contact of the two bodies on the egrefs of Mercury were determined as follows:

By	Lalande - -	0^h	$6'$	$29''$	$7'$	$56''$
	Meffier - -	0	6	49	8	20
	Lalande jun. -	0	6	44	8	19
	Bouvard - -	0	6	54	8	19
	Mechain - -	0	6	45	8	30
	Burckhardt -	0	6	45	8	20

C. Lalande takes as the mean terms of the two contacts $0^h\ 6'\ 49''$, and $0^h\ 8'\ 19''$;

From which he deduces the egrefs of Mercury at

$0^h\ 7'\ 34''$;

The apparent diftance of the centres at that moment,

$16'\ 8{\cdot}3''$;

And the fame diftance reduced to the centre of the earth,

$16'\ 10{\cdot}0''$.

By then comparing three differences of declination felected from twenty-five, which were meafured by C. Meffier during the tranfit, he deduces from them the fhorteft diftance of the centres, namely $65''$: and combining it with the diftance of the centres at the moment of the egrefs, he is enabled to find the difference in longitude and latitude of the two bodies, and the time elapfed between the middle of the tranfit and the egrefs. We fhall not follow the detail of his procefs any further, as our aftronomical readers may eafily fupply what is here omitted; and to others it would be fuperfluous. We only ftate the refults which C. Lalande obtained by this firft method.

He found the true conjunction at

$9^h\ 2'\ 40''$ mean time;

The longitude, reckoned from the mean equinox for the moment,

$7^s\ 16^\circ\ 17'\ 9''$;

The geocentric latitude,

$53''$ North;

The heliocentric latitude,

$1'\ 54''$;

The correction of the tables: — $13''$ in longitude.

C. Lalande

C. Lalande re-commenced his calculations; substituting for the differences of declinations the observation of Mercury's passage of the meridian, made the same day by his nephew and C. Burckhardt; and by these means found $2''$ less in longitude, and $6''$ less for the latitude, at the moment of the egress.

He determines the geocentric latitude at the time of conjunction to be $56{\cdot}5''$, which gives the place of the node $1^s\ 16^\circ\ 0'\ 37''$, further advanced by $1'\ 46''$ than in the tables; and as C. Delambre had found by the passage of 1799 that this element ought to be increased by $1'$, C. Lalande adopts a mean correction of $+\ 1'\ 23''$, which makes the place of the node in 1801 to be

$$1^s\ 15^\circ\ 58'\ 54''.$$

By comparing this determination with that which he deduced from the transit of 1677, he found for the annual motion of the node $43{\cdot}98''$ instead of $43{\cdot}3''$, which he had before.

To ascertain whether the position which he gave to the aphelion of Mercury was exact, C. Lalande examined again the transit observed by C. Delambre in 1799, taking into account the perturbations calculated by M. Oriani, and the error in the tables of the sun, and he found the same error of $13''$ as in that of this year, though the anomalies were very different. He consequently thought that this error ought to be ascribed only to the epoch of the mean motions: but after a communication from Dr. Maskelyne in regard to a correction of $4''$ to be made in the right ascensions, which he assigned to the positions of the principal stars employed for determining the places of the sun, the error in the tables of Mercury would be reduced to $9''$, and the epoch of the mean motions of this planet would consequently be for 1801,

$$5^s\ 11^\circ\ 53'\ 32''.$$

By distributing this error to the secular motion it would be reduced $6''$, and would become

$$2^s\ 14^\circ\ 4'\ 4''.$$

In a word, the transit of November 9, this year, has fully confirmed the result which C. Delambre deduced from that of 1799 in regard to the diameter of Mercury. C. Delambre had obtained for this diameter as seen from the sun $6{\cdot}3''$; and C. Lalande found $6{\cdot}2''$, while in his Astronomy it was $6{\cdot}9''$.

C. Messier communicated to the class a particular account of his observation of the transit of Mercury, during which he successively determined twenty-five positions of that planet,

8 comparing

comparing it either with the ſun's limb, or to a very conſiderable ſpot which appeared on that body, and of which the diameter was 25′ of a degree. He determines the moment of the egreſs of Mercury's centre at 7′ 6″ true time; and this planet's paſſage of the meridian 55″ before that of the ſun's centre.

C. Meſſier's memoir contains a detailed view of the determinations he obtained, and is accompanied with a drawing which repreſents the apparent route of Mercury on the ſun. It exhibits a luminous ring, with which Mercury ſeems to be ſurrounded. This circumſtance, peculiar to the obſervation of C. Meſſier, was remarked by him in the tranſit of 1799; it was obſerved alſo at Montpellier, in 1736, by Plantade; and at Upſal, in 1736, by M. Proſperin. This ring exhibited a very faint light, and of a colour different from that of the ſun. Its diameter towards the end of the tranſit was 1′ 19″, and that of Mercury 17″.

EXPERIMENTAL PHILOSOPHY.

On the Method of magnetizing to Saturation.

To apply with conſtancy to the ſame objects, and to vary their combinations in every manner poſſible, are the conditions on which nature conſents to diſcloſe her ſecrets to thoſe who interrogate her. It was by fulfilling them with an aſſiduity and ſagacity worthy of ſucceſs that C. Coulomb attained to his intereſting diſcoveries in electricity and magnetiſm, and by impoſing on himſelf the taſk of illuſtrating every part of theſe important branches of philoſophy. *Magnetizing*, the perfecting of which is of ſo much importance to navigators, could not eſcape his attention. Very vague notions had hitherto been acquired in regard to the intenſity of the magnetic force which ſteel is capable of acquiring in its different ſtates; and it was meaſured in general by the weight of the piece magnetized. But it is of the greateſt importance here to know the energy with which needles tend to return to their direction after they have been removed from it; and this C. Coulomb meaſures directly, by determining, according to Borda's views, and by means of very nice ſuſpenſion, how many oſcillations theſe needles perform in a given time.

After comparing the methods of magnetizing propoſed by Duhamel, Knight, and Æpinus, to give a needle all the directing force it is capable of receiving, the author decides in favour of that of Æpinus. He found that it is moſt advantageous to make the needles long and broad, but not thick.

thick. C. Jekel has eſtabliſhed a manufactory in order to make an uſeful application of theſe reſults for the uſe of the navy.

PHYSICAL PART, read by Lacroix.

On the Stones ſuppoſed to have fallen from the Clouds.

The attention of philoſophers has been again directed to the ſingular ſtones the origin of which is unknown, and which are ſuppoſed to have fallen from the clouds. The French chemiſts were deſirous of proving by experiments the identity of theſe ſtones, and of aſcertaining their component parts, already indicated by Mr. Howard.

C. Vauquelin procured ſome ſpecimens of the ſtones, analyſed by Mr. Howard, found at Benares in the Eaſt Indies, in Yorkſhire, at Siena in Italy, and at Bologna: to which he added ſome of thoſe which fell in France in 1789; at Barbotan near Roqueton, and Creon in the pariſh of Juliac, in 1790. He remarked, as Mr. Howard did, that theſe ſtones have ſuch a perfect reſemblance to each other that it is almoſt impoſſible to diſtinguiſh them. He was convinced by various analyſes that they all contain the ſame principles, namely, ſilex, manganeſe, iron, nickel, and ſulphur. Theſe reſults, analogous to thoſe obtained by Mr. Howard, and the work in which Dr. Chladni, known by his ingenious experiments on vibrating ſurfaces, has collected all the accounts publiſhed reſpecting the fall of theſe ſtones, concur to render it probable that their origin is foreign to our globe; for hitherto none of a ſimilar kind have been found in the interior parts of it.

The reading of this intereſting memoir gave riſe to a diſcuſſion the reſults of which muſt be here mentioned, as they afford new motives to induce philoſophers to examine and appreciate the different teſtimonies, in conſequence of which the ſtones in queſtion have been ſuppoſed to have fallen from the clouds. When a phænomenon is announced, if we were able to aſcertain, by a complete enumeration of the different phyſical agents, that none of them is capable of producing it, the impoſſibility of the phænomenon would be the evident reſult, and conſequently the falſity of the account.

But, on the other hand, when we find a cauſe which eſtabliſhes the probability of it, if ſound logic forbids us to aſcribe it excluſively to this cauſe, it commands us at the ſame time to ſubſtitute doubt for complete negation, and to employ every means poſſible of confirming the fact, becauſe it is not repugnant to the general laws of nature.

Chemiſts

Chemiſts at preſent would be much embarraſſed to find in the atmoſphere the component principles which have been diſcovered by analyſis in the ſtones given to them as having fallen from the clouds; and on this account they would naturally reject ſuch events as abſurd. But C. Laplace has mentioned an explanation, which he announces not as the only one which could be given of them, and not to prove their exiſtence, but to ſhow that we ought not to reject them as abſurd, and to ſuſpend our opinion until time has procured ſome further illuſtration.

It is ſhown, by a very ſimple calculation, that a body projected from the moon would require only a velocity nearly quintuple that of the bullet of a 24-pounder diſcharged with a quantity of gunpowder equal to half its weight, to proceed to a diſtance from that ſatellite where the intenſity of its attraction would be the ſame as that of the earth. The body, when it had paſſed this point, being in the ſphere of the activity of our globe, would neceſſarily fall to its ſurface. The appearance of very conſiderable volcanoes obſerved on the ſurface of the moon does not render ſuch a conjecture improbable; but, independently of eruptions, which may be more or leſs uncommon, it will not often happen that the direction of the projection will be that which the combined motions of the earth and moon require in order that a projectile thrown from the latter body may meet with the former.

The atmoſphere of the moon, which is doubted by many aſtronomers, is ſo rare and of ſo little extent that it could oppoſe only a very feeble reſiſtance to thoſe bodies which might move in it. The caſe is not the ſame with the terreſtrial atmoſphere: it reduces almoſt to a tenth of its extent the largeſt range of a piece of ordnance; and the reſiſtance it oppoſes to rapid motion is ſuch, that to make a body projected from Veſuvius reach France, it would be neceſſary that it ſhould have a projection far greater than that which would carry a lunar body to the limits of the ſphere of the activity of that ſatellite.

It is therefore not poſſible to ſuppoſe that ſtones found at a diſtance from terreſtrial volcanoes are the product of the eruptions of theſe mountains: and mineralogy alſo oppoſes this explanation; for none of the volcanic productions known are analogous to thoſe ſuppoſed to have fallen from the clouds.

METE-

METEOROLOGY.

On the Variations of the State of the Heavens in the Mean Latitudes between the Equator and the Pole, and the essential Circumstances by which they are accompanied.

The influence of meteors on the results of agriculture has rendered it of importance at all times that the law of the succession of these phænomena should be known; and the great advantages which would arise to mankind from the possibility of foretelling the nature of the seasons, sufficiently justifies all the fruitless attempts hitherto made to accomplish that end.

Being much struck with these advantages, C. Lamarck was discouraged by the bad success of those who had preceded him in this career; and from continuing to pursue it with ardour, after publishing in different works the causes which he assigns to the prevailing meteorological constitutions, he has given in a late memoir an examination of the variations of the state of the heavens, that is to say, of the atmosphere: he refers this state,

1st, To the influence of the sun's light:

2d, To that of the winds.

But he is of opinion that in the temperate zones the influence of the winds on the temperature of the strata of the atmosphere is much stronger than that of the light of the sun; and that there thence result in the density and heat of these strata, which naturally become rarer and colder the higher they go, inversions to which he ascribes the formation of the clouds.

The discordance of the effects which the same wind produces at different times seemed to oppose to the establishment of a theory of these effects an insurmountable obstacle: but from numerous observations C. Lamarck is of opinion, that besides the direction and nature of the winds alone, attention ought to be paid also to the height at which they blow in the atmosphere.

Of the facts collected by the author, and which he considers as sufficiently proved, we shall mention the following: "When a *north-west* and a *south-east* wind prevail simultaneously in two different strata of the atmosphere, if the *south-east* be the lower one, we may expect to see the weather become clear; but if this wind be the higher, the contrary will take place."

XXXIV. *Intelligence and Miſcellaneous Articles.*

ASTRONOMY.

We are indebted to a very accurate and much valued correſpondent for the following tables, which cannot but prove highly acceptable to ſuch of our readers as are deſirous of knowing in what part of the heavens the two new planets may be expected to be found. We believe no Ephemeris has yet been publiſhed containing their right aſcenſions and declinations. Baron Von Zach has publiſhed one in which their geocentric latitudes and longitudes are given; but this work being written in German is in the hands of but few people in this country.

	Geocentric Motion of Ceres Ferdinandea.					Geocentric Motion of Pallas.				
1803.	Right Aſcenſion.			Declin. South.		Right Aſcenſion.			Declin. North	
April 3	18h	54m	47s	23°	6	18h	47m	0s	13°	33′
6	18	57	21	23	10	18	48	36	14	3
9	18	59	43	23	15	18	50	4	14	34
12	19	1	4	23	19	18	51	20	15	5
15	19	3	56	23	24	18	52	28	15	36
18	19	5	46	23	30	18	53	24	16	7
21	19	7	23	23	36	18	54	8	16	38
24	19	8	49	23	43	18	54	44	17	9
27	19	10	3	23	50	18	55	4	17	39
30	19	11	5	23	58	18	55	16	18	9

The above table, containing the geocentric motion of the two new planets, Ceres Ferdinandea and Pallas, for the enſuing month, is ſelected from an Ephemeris calculated by Mr. Gauſs, of Germany, of whoſe abilities as a calculator the world has already been fully convinced. Mr. Gauſs does not expect that the obſerved places of theſe planets when they ſhall be again found will agree very correctly with his Ephemeris, as there has not yet been a ſufficient number of obſervations made to ſettle the elements of their motions with ſuch a degree of preciſion; but he hopes his calculations will render them very eaſy to be found: thoſe gentlemen, therefore, who are provided with equatorials, or inſtruments for taking angles out of the meridian, will no doubt

doubt be soon able to find both, or at least Pallas, whose situation is now become pretty favourable, being at a sufficient distance from the sun to be seen in the morning when the weather is clear. It does not appear likely that Ceres Ferdinandea, from her great south declination, will be seen here till the latter end of April, or perhaps the beginning of May; but those astronomers who are situated in more southern latitudes will view her under more favourable circumstances, and may perhaps be able to find her sooner.

HUMBOLDT'S TRAVELS.

Where Alexander von Humboldt may be at present is not known even to his relations; but all the observations which he collected up to the beginning of March 1801 have lately arrived safe in Europe. He entrusted this valuable deposit, which consists of four bound volumes and three manuscript bundles, a roll of plans, and a number of drawings of plants, to one of his friends at the Havannah, where he then was, to be sent to Spain by a proper opportunity. They arrived in the beginning of September 1801, and have since been transmitted to Berlin.

FOSSIL BONES.

Two horns, with the head and several bones of an unknown animal of a monstrous size, have lately been found in the Mologi circle, of the government of Jaroslawi, on the banks of the Mologa, on an estate belonging to count Alexei Iwanswitch Puschkin. The length of the head is two ells Leipsic measure *, and the breadth on the forehead one ell eight inches, (two feet five inches.) The horns are like those of an ox, are about four ells in length (six feet eleven inches), and in the thickest part are about an ell in circumference (one foot nine inches). Gmelin, as is well known, says that, besides bones of the mammoth, (different however from those of the American mammoth,) heads with horns of an extraordinary size are sometimes found in Siberia. He himself carried with him to Petersburgh a head of this kind, which in all probability is still preserved in the cabinet of curiosities belonging to the Academy of Sciences. It will be interesting to natural history to compare this head with the one lately found, in order to ascertain whether they belong to the same species of animal. At any rate, these heads seem to afford a new proof, in opposition to the opinion of Daubenton, Buffon, and other naturalists, that there existed formerly species of animals now become extinct.

* About one yard six inches.

ANOTHER

ANOTHER NEW METAL.

Profeffor Tromfdorff, of Erfurt, has publifhed the following notice:—" One of my mineralogical friends, whofe name I fhall make known at a proper time, found lately a particular fubftance which he tranfmitted to me for examination. Though the quantity was fmall, I am however convinced that it is a *new metal* combined with fulphur. The characteriftic marks of this metal are: It belongs to the volatile metals: with fulphur it forms a mafs which melts like wax, and which cryftallizes; with fulphureous acid it gives a reddifh folution; with nitrous acid and nitro-muriatic acid it gives a yellowifh folution; muriatic acid has no action on it warm: from acid folutions it is precipitated green by the pruffiate of potafh; of a fteel gray by tincture of galls; chamois yellow by *hydrothion-ammonia* *; by carbonate of potafh it is precipitated as a white oxide; it is not precipitated from its folution by cauftic ammonia, and it is probable that it forms with it a double falt. I fhall obferve in the laft place, that this new fubftance is found in Germany. A further account of it will be publifhed in my journal."

Erfurt,
Jan. 1803.

* By this term we conceive the author to mean a folution of carbonate of ammonia, in contradiftinction to pure (cauftic) ammonia, which he afterwards mentions.

XXXV. *Letter from Dr.* Barton *to Professor* Zimmermann, *on the fascinating Faculty which has been ascribed to the Rattlesnake, and other American Serpents* *.

DEAR SIR, Philadelphia, Feb. 12, 1800.

I HAVE never yet received the translation which you have made of my " Memoir concerning the fascinating Faculty which has been ascribed to the Rattlesnake, and other American Serpents." I feel flattered by your kind notice of that little production, one of my first essays in natural history, and one to which, I confess, I devoted a good deal of attention. By transferring my sentiments on the subject which I have touched into the language of your country, you have, no doubt, contributed to draw the attention of the learned to the discussion of the question, whether serpents are endued with the power of fascinating other animals.

I did not, before this day, know that our learned friend professor Blumenbach, of Göttingen, had published some Remarks on the Memoir, in Voigt's *Magazin für den neuesten zustand der Naturkunde*, part ii. I have not seen the magazine, but have met with a translation of the professor's paper in the Philosophical Magazine †, published in London by Mr. Alexander Tilloch. In this letter I am going to trouble you with some further remarks, which you are at liberty to make use of in any way you may think proper.

I shall not pursue the professor in the precise order of his remarks. I shall first take notice of his defence of that passage in his Manual of Natural History ‡, which I particularly examined in my memoir, and which he seems to think I have criticised with somewhat of severity. The following are Mr. Blumenbach's words, as I have translated them in the memoir:—" That squirrels, small birds, &c. voluntarily fall from trees into the jaws of the rattlesnake lying under them, is certainly founded in facts: nor is this much to be wondered at, as similar phænomena have been observed in other species of serpents, and even in toads, hawks, and in cats, all of which, to appearance, can, under particular circumstances, entice other small animals by mere steadfast looks. Here the rattles of this snake (the rattlesnake) are of peculiar service; for their hissing noise causes the squirrels, whether

* Communicated by Dr. Barton. † For December 1798.
‡ Handbuch der Naturgeschichte.

whether impelled by a kind of curiosity, misunderstanding, or dreadful fear, to follow it, as it would seem, of their own accord. At least," continues Mr. Blumenbach, "I know, from well-informed eye-witnesses, that it is one of the common practices among the younger savages to hide themselves in the woods, and, by counterfeiting the hissing of the rattlesnake, to allure and catch the squirrels*."

On this passage I made some remarks, which were brought together under three distinct heads. I observed, 1st, That "the faculty of fascinating is by no means peculiar to the rattlesnake, but is attributed as extensively to the black snake, and other serpents, which are not furnished with the crepitaculum, or set of bells." 2dly, That "some persons, who have seen the rattlesnake in the supposed act of charming, assure me that the reptile did not shake its rattles, but kept them still;" and lastly, I was inclined to think that there was no solid foundation for the story upon which, in part at least, Mr. Blumenbach has founded his theory.

It is certainly the prevailing opinion in this country, that the black snake and other serpents, as well as the rattlesnake, are endowed with the faculty of fascinating or charming other animals. It is well known that none of the serpents except the different species of crotalus are furnished with the *crepitaculum caudæ*, or rattle, and no attempt has been made to point out the difference (if there be a difference) in the modes of fascinating employed by these several serpents, with the exception of the remark made by a few of the Indians and Whites, that the rattlesnake charms with its rattle †. But we shall afterwards see that this is by no means the general opinion among the Indians or Whites.

Since the printing of my memoir, I have been assured by a very intelligent person ‡, who, living in a part of the country which abounds in rattlesnakes, has had many opportunities of attending to the manners of these serpents when watching for their prey, that at such time the rattlesnake does not move his rattle, but lies still. This is a confirmation of the fact mentioned in my memoir. "It is very probable," however, as M. Blumenbach observes, "that the case here may

* See a Memoir, &c. pages 46 and 47.

† See a Memoir, &c. pages 14 and 15.

‡ Mr. Samuel Preston. "Dr. Mead (says Mr. Preston) supposes the rattle on their tail to be useful for that purpose (viz. charming); but he is much mistaken, as I have actually seen them engaged in the process a number of times. They do not make any noise with their rattle; they lie perfectly still, with an open mouth and sparkling eyes."—Letter to me, dated Stockport, August 7, 1798.

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be altered by circumftances;" that is, that the reptile whilft endeavouring to obtain its prey fometimes fhakes its rattle and fometimes keeps it ftill. I am now, however, fully perfuaded that the latter is the general cafe; and the more fo, becaufe it feems to be afcertained that the rattlefnake feldom fhakes his rattle unlefs when he is irritated.

If then this ferpent does not always, nor even generally, move his rattle at the time he is watching for his prey, it is, I think, fomewhat unphilofophical to afcribe fo much to the "hiffing noife" of the inftrument as Mr. Blumenbach has done. "This lazy animal, when lying on the ground, might certainly," fays the profeffor, "employ that fingular organ for enticing animals, as well as the ceraftes employs its horns for the fame purpofe, at leaft according to common report."

I will readily allow, that if the ceraftes of Egypt is capable of charming by means of the horns upon his head, the rattlefnake might, without much ftretch of the imagination, be fuppofed capable of charming by means of the horny bells upon his tail. But here Mr. Blumenbach attempts the folution of one difficulty by having recourfe to another difficulty; or, rather, he feems difpofed to cut the knot of fafcination, as it refpects the rattlefnake, by means of a ftory which has never been proved to be a fact, and which, I cannot but think, is one of the many improbable tales in natural hiftory. I know it is fanctioned by Pliny * and Solinus. But, alas! how many hundred anile ftories has Pliny told! and who does not know that Solinus is often the fervile copier of Pliny?

In the difcuffion of curious queftions like the prefent, I can feel pleafure even in furnifhing my opponent with implements with which to defend himfelf. With this difpofition of mind I will here mention a fuppofed fact, which is a good deal fimilar to that related of the ceraftes. I do not doubt that it is as worthy of belief. There inhabits the lakes and rivers of many parts of North America a very curious fpecies of efox or pike, which is commonly known by the name of the gar fifh or bill fifh. The upper jaw is lengthened out into a long bony roftrum, or protuberance, which has given it the name of *bill fifh*. Although this fifh is known to live almoft entirely upon other fifh, to which he proves very deftructive, we are told that the gar hides himfelf in the reeds in fuch a manner, that nothing but the curious roftrum, which he thrufts out of the water in a perpendicular pofition,

* "Ceraftis corpore eminere cornicula fæpe quadrigemina: quorum motu, reliquo corpore occultato, folicitent ad fe aves." C. Plinii Secundi Naturalis Hiftoriæ Lib. viii. cap. 23.

can be seen. Different kinds of birds, which come to rest themselves upon the reeds, mistaking the fish's bill for a reed, or dry piece of wood, perch upon it also. He then opens his mouth, and generally makes an immediate prey of the misguided bird.

This story is related by a very respectable writer, father Charlevoix, who adds a circumstance which I must not omit to mention, especially as it would seem to show that there is some hidden (we will call it a *fascinating*) virtue in the gar's bill. The Indians say, that the sharp teeth which are distributed along the edges of this instrument are a "sovereign remedy against the head-ach, and that pricking with one of these teeth where the pain is sharpest, takes it away instantly *."

But to be serious: As most, if not all, animals are furnished with an organ of hearing, so it is not improbable that different sounds, particularly the sounds of musical instruments, have something charming or attractive to certain species of animals. Passing by the stories that are told of the *trichechus manatus*, or sea-cow, the common mouse, and some other animals, I will here mention a fact related by Dr. Odier on a very respectable authority, and I relate it the more confidently because it has been confirmed to me by several persons of credit. The iguana † of the West Indies is said to be so fond of music, that at the sound of an instrument this ugly looking lizard becomes almost motionless, and is easily taken by a noose ‡.

But I must return to Mr. Blumenbach. "I know," says

* A Voyage to North America, vol. i. pages 117 and 118. English translation.

† Lacerta iguana of Linnæus.

‡ See Epistola Physiologica, Inauguralis, de Elementariis Musicæ Sensationibus, Nota 32, Edinburgi 1770. It were much to be wished that some ingenious man would favour us with a memoir concerning the influence of music upon different animals. Some interesting materials for such a work are to be found scattered through a number of writers both antient and modern. But new materials might readily be collected, since it would not be a difficult task to make experiments. Much curious physiological knowledge would result from such an inquiry: and I greatly mistake if the inquiry would not somewhat tend to diminish the quantity of our prejudices against animals that are unquestionably innocent. Should it have this effect, how great would be the gain to a benevolent mind! Nurtured among prejudices of different kinds, we are at once miserable and unjust. I must confess that I have dropped some of my prejudices against the amphibia (See a Memoir, &c. p. 45, note) since I have learned that the iguana is pleased with the music of the West Indians; and that a little garden lizard listened, "with a breathless attention," to the sound of a lady's piano-forte.—For a very interesting instance of this kind, see the Analytical Review for January 1789.

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he, " from well-informed eye-witnesses, that it is one of the common practices among the younger savages to hide themselves in the woods, and, by counterfeiting the hissing of the rattlesnake, to allure and catch the squirrels." After quoting this passage, I observed in my memoir, that " I have inquired of Indians, and of persons who have resided for a considerable time among the Indians, and they appear to be as ignorant of the circumstance as I am myself." I continued, " I am inclined to think that Mr. Blumenbach has been imposed upon," or, perhaps, that a circumstance which I have related may have given rise to the story *. Mr. Blumenbach has since informed me by letter, and now informs the public in his Remarks, that he received his " information from major Gardner, who, with his family, resided many years in East Florida. He is," says the professor, " a very intelligent naturalist, an accurate observer, and certainly would be very far from imposing upon me."

I knew not, when I printed my memoir, from whom Mr. Blumenbach received his information. It was not, however, unnatural for me to suppose, that he had been " imposed upon," because I well know that some of the most respectable naturalists and historians of Europe have often been most grossly deceived by travellers who have visited this country: hence the many tales and scandalous stories which crowd and deform some of the works of your most celebrated writers. Such tales and stories are the following:—That the Indians have no beards; that they have very small appetites; that they are greatly addicted to the " antiphysical vice;" that *none* of the tribes knew any-thing of the use of salt before the Europeans came among them; that they cannot carry their arithmetic beyond the numeral three; &c. &c. &c.

I have lately made further inquiries of the Indians concerning the stratagem which, Mr. Blumenbach says, the younger savages employ to allure to them squirrels. I can learn nothing concerning it. I am still disposed to think that there is but a slender foundation for the story. I am certain that it is not a *common* practice among the Indians. Persons who have resided for many years among our northern and western Indians have never heard of it: neither have intelligent traders and interpreters from the very country in which major Gardner resided. Anxious to ascertain the truth, I shall extend my inquiries, and, should I learn that the Indians do actually employ the stratagem, I shall endeavour to be the first to inform Mr. Blumenbach of the success of my research.

* See a Memoir, &c. pages 48 and 49.

I shall conclude this part of my letter with two observations; viz. 1st, If it be a fact, as I have asserted, that the rattlesnake, while watching for his prey, seldom moves his rattle, the story related by major Gardner must, independently on any other facts, appear highly improbable. 2dly, Even admitting the fact, that the rattlesnake does shake his rattle while employed in the supposed act of charming, I think the greater number of the favourers of the existence of a fascinating quality in this serpent ought, upon a careful consideration of the subject, to give up Mr. Blumenbach's explanation of the business. They tell you that the bird or squirrel is often seen precipitating itself from the top of a lofty tree into the jaws of the serpent lying at the bottom. Now, is it likely that the noise of the rattle can be distinctly heard at the distance of sixty, eighty, or a hundred feet, in a forest where all else is not silence; in a forest where rooks, and ravens, and jays, wood-peckers, and many other species of birds, utter their various cries or notes, which are mixed, and often confounded, with the noise of tree-frogs, locusts, and a hundred other animals? I think, sir, you will admit with me, that it is very improbable, if not impossible, that the rattle could affect the bird at such a distance; and I am disposed to believe, that, after reading the preceding observations, you will not think Mr. Blumenbach's system is so capable of being maintained as that ingenious gentleman seems to suppose it is.

Mr. Blumenbach, in taking notice of my theory of accounting for the supposed fascinating power of serpents, informs us, that with this method of explaining the phænomenon he has been acquainted since 1785, from an essay by professor Michaëlis, in the Göttingen Magazine for January of that year. In justice to Dr. Michaëlis, I shall here quote his words, as they are given by Mr. Blumenbach:—"Others believe that it is owing merely to the care of the old ones for their young, which throw themselves between the latter and their enemies, and by these means become a prey to them. One of my friends, Mr. David Colden, at Flushing, an amateur of natural history, and son of governor Colden, whose service to science is so well known, assured me that he had several times seen birds fascinated by snakes, but always found the nest of the bird either with eggs or young ones in the neighbourhood; which made the spectators give up the idea of fascination. But," Mr. Michaëlis adds, "I know some instances where no nest could be in the neighbourhood, and where, though the snake was at first at a great distance from the bird, it nevertheless fell towards it."

From

From this quotation it appears that I was not the first person who endeavoured to explain the supposed fascinating power somewhat in the manner I have done. I have not asserted that I was. But I certainly neither did nor could borrow the explanation from Mr. Michaëlis, whose "valuable essay," as Mr. Blumenbach calls it, I have never yet seen. My theory, which every day's inquiry serves to strengthen, was the result of a great deal of attention to the subject: and I have enjoyed as many opportunities of investigating the truth as Mr. Michaëlis did. With respect to that ingenious gentleman, I should have allowed him more merit had he adopted Mr. Colden's explanation; and I can allow him very little for rejecting it, merely because, in some instances, no nest could be found in the neighbourhood, and because, "though the snake was at first at a great distance from the bird, it nevertheless fell towards it." It surely does not follow, because no nest could be found, that none existed. The schoolboy well knows the difficulty of discovering the nests of many species of birds; and the naturalist, who ought to be acquainted with the arts employed by these animals to conceal, from man and other enemies, their nests, should make still greater allowance for the difficulty of discovering these nests. As to Mr. Michaëlis's other assertion, that, "though the snake was at first at a great distance from the bird, it nevertheless fell towards it," I will not positively deny it, until I learn whether that gentleman has himself witnessed any thing of the kind. But, in the meanwhile, I must say, that I have no reasons to think that I have been precipitate in advancing what I have advanced on this subject in my memoir.

I do not perceive that Mr. Blumenbach has made any other attempt to controvert my theory, except in so far as he has mentioned Mr. Michaëlis's two observations just noticed. On the contrary, in the new edition of his Manual, the professor has quoted my memoir, and expunged the story about the ringing of the serpent's tail *. Of Mr. Michaëlis's essay he makes no mention. And here, before I adduce any additional facts in support of my explanation, I cannot forbear to observe, that I do not think Mr. Blumenbach has done justice to this part of my memoir. In particular, the fine fact communicated to me by the late Mr. Rittenhouse, of which he has made no mention, is worth a whole volume of speculations on the subject. I doubt not that my learned Göttingen friend had as high an opinion of the fact as I have.

* Handbuch der Naturgeschichte, p. 242; Göttingen 1797.

Before I proceed any further in my reply to Mr. Blumenbach, I beg leave to trouble you with some facts which are a good deal similar to those related in my memoir. They certainly favour the system which I have advanced. Independently, however, of their connection with the subject of the memoir, they appear worthy of preservation; for they serve to illustrate, in some degree, the history of the manners and instincts of serpents; a subject which has been too much neglected by naturalists.

A species of coluber, which is commonly called the chicken snake in the southern parts of the United States, of which it is a native, frequently climbs up the loftiest trees in pursuit of young birds. One of my friends *, when he was in Georgia, several years since, had an opportunity of seeing one of these snakes in a situation which furnishes a striking argument in favour of my opinion. The active reptile having seized upon a young martin † (which had left its nest for some days), upon a walnut-tree, at the height of about thirty feet, had not a little difficulty in swallowing the young bird. Having taken in the head first, as is commonly the case with our serpents, the bird made great resistance by the flapping of its wings; so that the serpent could only swallow the head and neck. Whilst the wings of the bird were in motion, numbers of the old martins collecting together flew about the snake and attacked him with their bills. Here, as in the instance related by Mr. Rittenhouse, the old birds were actuated by the instinct of saving their young.

The following facts were communicated to me by Mr. John Heckewelder:—" In the summer of 1770," says this gentleman, " while I was fishing under the bank of Leheigh ‡, I heard, for the space of near an hour, the sound of a ground-squirrel, seemingly in distress, on the top of the bank. At length I went up to see what was the matter with the squirrel; when, to my utter astonishment, I discovered the animal about half way up a bush, but running sometimes higher up, sometimes lower down, and a very large rattlesnake at the root of the bush on which the squirrel was. Here I was immediately struck with the idea that the snake was in the act of inchanting, and I hoped now to become fully convinced that the rattlesnake obtained its prey altogether in this manner, as I had often heard reported. I therefore sat down quietly on a log about six yards distance, where I had

* The ingenious Mr. William Bartram.

† Hirundo purpurea.

‡ The principal western branch of the Delaware, which runs by Bethlehem.

a full

a full view of both the fnake and the fqurirel. Sometimes I thought the fquirrel going down for the laft time, and to enter the jaws of the fnake; but it would again return up the bufh with the fame livelinefs it had run down. Finding, finally, no material alteration in the fquirrel or its motions, and my patience being exhaufted, I determined on killing the fnake, and examining into the cafe of the fquirrel, viz. what ftrength, &c. it yet retained after being charmed for fo long a time; for, by this time, the fuppofed charm had lafted near three hours. I ftruck at the fnake with a long pole, but miffed it; upon which it ran down the bank where I had been fifhing. Remaining by the bufh on which the fquirrel was, I hailed a man on the oppofite fide of the river, defiring him to crofs in a canoe and kill the fnake under the bank. To which he immediately complied; but likewife miffing his ftroke, on account of the bufhes, the fnake took up the bank again, where I killed it. We now both joined to fhake the fquirrel down; but it had both fenfe and ftrength enough to climb to the very top, I fuppofe near twenty feet high. However, we brought it down to the ground; and though it had fallen about two yards from the bufh, it well knew its hole in which it dwelt, and this was at the root of the bufh, and exactly at the fpot where the fnake had lain. Here the myftery was cleared up to us at once. We conjectured that the fnake was either watching for the fquirrel to come down to enter its hole, or for its companion or young, which were probably in the hole, to come out; all of which were fufficient to caufe anxiety in the fquirrel on the bufh. The dexterity, however, of the fquirrel in making its way into the hole, and at the very place where we ftood, fhowed plainly that it retained its full ftrength and fagacity, and had by no means fuffered from the charm of the fnake *."

" A fimilar circumftance, to which I was alfo an eye-witnefs, happened," fays Mr. Heckewelder, " in the year 1771, near Wyalufing, on Sufquehanna, where the cries of the chewink † drew my attention to the fpot. The rattle-fnake was juft entering a heap of brufh, in which the old ones had their neft with young. I fuppofed that one or the other of the old ones, with the young, would have become its prey, had I not approached and relieved them by killing the fnake ‡."

* Letter to me, dated Bethlehem, Auguft 5th, 1796. Mr. Heckewelder has fince informed me, that the fnake, during the whole of the time he attended to it, never fhook its rattle.

† The Fringilla erythrophthalma of Linnæus.

‡ Letter to me, dated Auguft 5th, 1796.

The

The following fact is similar to one which I have related in my memoir *:—" In the year 1762, at Tuscarawas, on Muskingum, while going to fetch water out of the river, I observed," says Mr. Heckewelder, " a large black snake running out on a long limb of a large tree which stood on the water's edge. This limb was nearly horizontal over, and about twelve feet above the level of, the water. I could not, at first, conceive what the snake aimed at, until near the end of this limb I saw the animal stretch downwards, where I observed a hanging † bird's nest, pretty well concealed between some small boughs or leaves, into which the snake put its head, having strung its tail, with part of its body, round the limb above. Determined on killing the snake, if possible, I ran to the house for my gun, and shot the reptile, which fell into the river, with a young bird in its jaws."

" I and another person once observed a snake of this kind run up a tree pretty high, and put its head into a woodpecker's nest, where, as we supposed, it sucked the bird's eggs, it being too early for the young birds to be hatched ‡."

On these facts I shall not trouble you with any comments, but shall proceed with my examination of Mr. Blumenbach's Remarks.

[To be continued.]

XXXVI. *Observations on the different Theories of Philosophers to explain the Phænomena of Combustion.* By Charles Portal, *Esq.* §

THERE is no phænomenon in nature that has hitherto engaged the attention of philosophers with less success in the elucidation of its principles than that of combustion, and it at present affords one of the chief obstacles to the forming of a clear and satisfactory theory of chemistry. It is not singular, that a subject of so striking a nature, and abounding with a variety of such important phænomena, should have early attracted the attention of philosophers, and we accordingly find that it was made the subject of investigation by lord Bacon and Mr. Boyle.

These two philosophers were, however, more particularly confined in their inquiries to the nature of the unknown element called *fire*, nor did they reach sufficiently far in such inquiries

* See pages 67 and 68.
† Oriolus Baltimore of Linnæus.
‡ Letter already referred to.
§ Communicated by the Author.

inquiries as to frame any particular theory on the subject of combustion.

In referring back to the earlier periods of the history of chemistry, we shall find that Becher was the first philosopher who withdrew that science from the contracted limits of pharmacy and alchemy, and laid the foundation of the doctrine of phlogiston.

G. Ernest Stahl, whose genius was formed for the highest improvement of science, succeeded him; and it is to this philosopher that we are indebted for the first positive attempt to explain the phænomena, and to exhibit a regular theory of combustion.

The doctrine of phlogiston, as expounded by this celebrated chemist, is too well known to require being described at any considerable length.

It proceeded on the assumption, that there was only one substance in nature capable of combustion, which he therefore called phlogiston; and he held, that all bodies that were inflammable owed their combustibility only to the presence of this principle. Combustion, therefore, he considered merely as its separation in the form of light and heat; and such bodies as were not inflammable were thought to be devoid of it: for during the combustion of substances he taught that their phlogiston flies off, and the incombustible parts of them alone remain behind. Thus, if iron be exposed to a sufficiently strong heat it will undergo combustion, a complete alteration will take place in its constituent parts, and a residuum will be found left of an incombustible nature.

Stahl explained these phænomena in the following way: Iron he considered as a peculiar earth united to a certain proportion of phlogiston; when it was made to undergo combustion, the phlogiston which formed a part of it, and to which it alone owed its combustibility, made its escape, and there was left behind only the base, which was found to be no longer inflammable. Now, as this separation was always attended with the emission of light and heat, phlogiston was considered only as heat and light combined with some other species of matter in a peculiar and unknown way.

This doctrine was considered as deriving much support from the fact, that a body, after having undergone combustion, (*i. e.* by the dissipation of its phlogiston in the form of light and heat,) was converted into a body that was no longer combustible, but which might again have its combustibility restored by the addition of any inflammable matter. Thus, in the example before adduced, if, after the iron has undergone the

process

procefs of combuftion, and formed a refiduum that is incombuftible, we heat this latter fubftance with charcoal (an inflammable body), the metal will be again revived—phlogifton is imparted to it from the charcoal, and we again procure a combuftible fubftance. Thus, the light and heat which are evolved during combuftion are fuppofed to proceed from the burning body, and to be occafioned by the feparation of phlogifton from the bafe to which it is united.

Such is the outline of that theory of combuftion the foundation of which was firft laid by Becher, and afterwards reduced into a regular fyftem by the immortal Stahl. The phlogiftic doctrine of this chemift was univerfally adopted until the middle of the prefent century, when the difcoveries of Mayow and Hooke, of Prieftley and Lavoifier, led the way to a new theory of combuftion, which foon difplaced the former, and eftablifhed itfelf on its ruins. Stahl, from being wholly occupied in demonftrating the exiftence of phlogifton, feems to have paid no attention to the influence of air on combuftion. The experiments of Boyle and of Hales had already pointed out the influence of this element on many of the phænomena of combuftion, and the increafe of weight that bodies acquire during fuch a procefs, is a fact totally irreconcileable with the theory of phlogifton.

Many attempts, however, were made to overcome the weight of this objection by the difciples of Stahl; and they even had recourfe to the fuppofition that phlogifton was the principle of levity, and that, when abftracted from any body, that body, by lofing fo much abfolute levity, became heavier. So ftrongly were they fettered by the tenets of their mafter, that, without fubmitting to the labour of inveftigation, they implicitly adopted any illuftration that was conformable to his ideas; affording a ftrong proof of the defire that pervades the human mind to reduce every thing to firft principles, and to adopt hafty generalizations, without having recourfe either to an extenfive collection of facts or the more certain evidence of accurate experiment.

Whilft other chemifts were intent on reconciling the various difcoveries that had been recently made with the hypothefis of Stahl, Lavoifier (of a bold and creative genius) was led to call into queftion the very exiftence of phlogifton itfelf. This arofe from his having difcovered that during the procefs of combuftion a portion of air conftantly enters into union with the body which is made to undergo this operation, and that the weight of the air which difappears in the procefs is exactly equal to the increafe of weight gained by the

8

the body that has undergone combustion. These important facts led to the adoption of a new theory of combustion well known at present by the name of its illustrious author.

The theory of Lavoisier is founded on the absorption of oxygen by a combustible body, and proceeds upon the following principles:

1st, That combustion never takes place without the presence of oxygen gas.

2dly, That in every combustion there is an absorption of oxygen gas.

3dly, That there is an augmentation of weight in the products of combustion equal to the gas absorbed; that the oxygen likewise imbibed by the combustible body may be again recovered from the compound formed, and the weight regained will be equal to the weight which disappeared during combustion.

And, lastly, That in all cases of combustion there is a disengagement of light and heat.

These facts have been established by the most accurate experiments, and are too well known to require any further illustration; they incontrovertibly prove the general principle, "that combustion is only a play of affinities between oxygen gas, caloric, and the base of the combustible body. It is a further part of this theory, that the light and caloric which are evolved during combustion proceed from the oxygen gas, and that they are not emitted, as should follow from the phlogistic doctrine, from the combustible body.

As this theory, however beautiful, is not capable of explaining with clearness and accuracy many of the phænomena of combustion, Dr. Thomson, of Edinburgh, has lately (see Nicholson's Journal, New Series, for May and June 1802,) offered another which places this subject in a point of view somewhat different, and which certainly bids fair to enable us to estimate the phænomena of combustion with more success than has hitherto been done. Chemists have been lately accustomed to give to the term combustion, according to the foregoing theory, a new meaning, and to make it stand for the general combination of a body with oxygen. Nothing, however, can be more evident than the difference that in numberless instances prevails between the act of oxygenation of bodies and that of combustion, inasmuch as neither the phænomena attending them, nor the results arising therefrom, are the same.

It is probable that this error has arisen from the consideration that all bodies during their combustion combine with oxygen, without at the same time recollecting that this latter

effect

effect may be produced without any of the phænomena usually attendant on combustion; and that, though certainly all combustion presupposes the combination of oxygen with a base, yet this combination may be, and repeatedly is, effected where no combustion can possibly take place.

It is the object, therefore, of Dr. Thomson's theory to point out the difference which in numberless instances prevails between the act of oxygenation of bodies and that of combustion, and particularly to account, in a more satisfactory manner than has hitherto been done, for the emission that takes place during combustion of light and caloric. The two following are the leading positions of the doctor's theory:

1st, That during combustion all combustibles emit light, which previously formed a necessary ingredient to their own composition: and,

2dly, That the heat which is evolved during the process of combustion proceeds from the decomposition of oxygen gas.

It has been before observed, that by the phlogistic theory the light and heat are supposed to proceed from the combustible body; but that by the theory of Lavoisier they are held to proceed from the decomposition of oxygen gas, of which body they are considered as forming constituent parts.

In the infancy of chemical knowledge, and before the discovery of vital air, that the extrication of heat proceeded from the combustible body, was the only natural conclusion that could present itself to the mind; and as light and heat were considered as only modifications of the same substance, the supposition of course prevailed that both were evolved from the inflammable body.

Since, however, the later experiments of philosophers, and particularly those of Drs. Herschel and Woolaston, have disproved this supposed identity, it evidently becomes no longer necessary to trace these two substances to the same source; and this, as is before stated, is the case with the theory we are now reviewing.

That the caloric which is evolved during combustion should proceed from the decomposition of the oxygen gas, is, amongst a variety of other reasons, rendered the more probable from the consideration that bodies possess a greater share of caloric in the gaseous state than in any other; and consequently the probability is greatly strengthened, that the heat which is evolved during the process of combustion proceeds rather from the oxygen gas than from the inflammable matter, and that it is from the condensation of oxygen gas that caloric is chiefly evolved; or, according to the explanation of Lavoisier, that the oxygen of the gas, possessing a stronger affinity

for

for the base of the combustible body than for caloric, is thereby attracted, and that the heat combined with it is consequently set at liberty, and diffuses itself among the adjacent bodies.

To the second position of Dr. Thomson, that the light invariably proceeds from the combustible body, and not from the oxygen gas, there are much stronger objections, and such as, with our present collection of chemical facts, are, I apprehend, not readily to be explained.

It is a part of the theory of the doctor, that oxygen gas possesses no light: indeed this is so material a part, that, unless it can be substantiated, the theory is inadequate to elucidate the phænomena intended by it.

How shall we, however, reconcile the following facts on the above supposition? If nitric acid be exposed to the light, it changes colour; it first grows yellow, afterwards green, and lastly red, and oxygen gas is disengaged; and on examining the acid we find that it is converted from nitric into nitrous acid.

It is evident that, as this decomposition is of a chemical nature, the light that occasions it either combines with the oxygen to form oxygen gas, or with the acid to form nitrous acid: that the latter is not the case we are justified in supposing, because we find no difference between acid so procured and that gained by any other means, and we are necessitated to conclude that the light has combined with the oxygen, and that the latter is by this mean converted into oxygen gas. The same reasoning may be applied to the conversion of oxygenated muriatic acid by light into simple muriatic acid. Unless these facts can be otherwise satisfactorily accounted for, the position of Lavoisier still remains with all its force, that light is a constituent part of oxygen gas. That light forms a necessary part in the constitution of many bodies, is a fact too well authenticated to be refuted. The experiments of the Dutch chemists, who heated together the filings of different metals with sulphur under mercury; the phænomena of the pyrophori; the inflammation that takes place from the action of many of the acids on the oils; and the recent experiments of Dr. Hulme, illustrate this fact beyond the possibility of contradiction.

After a body has undergone combustion, we learn from this theory that it is deprived of light, and that it is only by means of a combustible body that light can be again transferred to the product of combustion. Thus water is considered by Dr. Thomson as a product of combustion, and consequently deprived of light. If, says he, we decompose this

this water by means of iron or zinc, we reſtore it to its former combuſtibility by occaſioning it to imbibe light, which is afforded it by the metal. If ſuch decompoſition is effected by means of iron, 73 parts of this latter unite with 27 of oxygen. Now, as every 27 parts of oxygen require about four of hydrogen to form water, of courſe theſe four parts of hydrogen are liberated during ſuch decompoſition: but, as it is not probable that combuſtibles are capable of combining with light in all proportions, it may be aſked, Whether the 73 parts of iron which are oxidated contain juſt light enough, and no more, to reſtore the combuſtibility of the four parts of hydrogen? for, if there be too much for that purpoſe, the ſuperabundant quantity ought to become viſible; and if too little, a part only of the hydrogen ſhould recover its combuſtibility, and be converted into gas. The ſame reaſoning may of courſe be urged with regard to the decompoſition of water by any other metal; for it is ſomewhat ſingular, that the combuſtible ſhould always contain and give out the preciſe quantity of light that is ſufficient to reſtore combuſtibility to the baſe of the product of combuſtion, and in no caſe either more or leſs. Theſe, as well as ſome other objections to the above theory, were pointed out by me in a paper entitled Remarks on Dr. Thomſon's Theory of Combuſtion, and inſerted in Nicholſon's Journal for the month of July 1802.

It ſhould appear, then, that we are not in poſſeſſion of a ſufficient collection of facts to enable us to form any theory of combuſtion that is perfectly free from objection, and calculated to explain all the phænomena attendant on it. Whether the light evolved during combuſtion is emitted from the combuſtible body or from the oxygen gas, muſt ſtill be conſidered as a matter of doubt; for the ſuppoſition ſeems perhaps the more probable, that it is partly derived from both. The ſubtile nature of light itſelf is highly adverſe to any inquiry into its real eſſence. The ſame obſervation will likewiſe apply to caloric. The theory laſt noticed is, however, poſſeſſed of a high degree of merit; it ſatisfactorily explains many phænomena that were before but little underſtood; it points out, with ſufficient perſpicuity, the difference that prevails between the act of oxygenation in bodies and that of combuſtion; and though certainly liable to ſome objections, it approximates the neareſt to a ſatisfactory explanation of the phænomena of combuſtion of any that have hitherto been offered.

CHARLES PORTAL.

*** Mr.

*** Mr. Portal is probably not aware that the theory which he attributes to Dr. Thomson as its author was first proposed by Dr. Gren, whose doctrine is briefly as follows:

Oxygen gas is composed of *oxygen and caloric—Combustible bodies* consist of *their respective bases* in chemical combination with the *matter of light—Free light* consists of the *matter of light* united to *caloric*.

Combustion, then, is a mere play of chemical affinities; the oxygen of the oxygen gas uniting with the base of the inflammable body to form an oxide or an acid, while the caloric of the gas unites with the matter of light of the combustible body, and forms free or visible light. By this theory, no combustible substance can be a simple body—by Lavoisier's, they may.—See Gren's *Principles of Modern Chemistry*, English edition, chap. ii. articles *Caloric*, *Light*, *Phlogiston*, *Combustion*.—A. T.

XXXVII. *History of Astronomy for the Year* 1802. *Read in the Athenæum of Paris December* 30, *by* JEROME LALANDE.

[Concluded from p. 179.]

ON the 7th of June I published the two last volumes of the large History of the Mathematics by Montucla. The fourth is almost entirely devoted to the history of astronomy and navigation, which I communicated to the present period.

There has appeared also, in two volumes quarto, with 23 plates, *Histoire de la Mesure du Temps par les Horloges*, by Ferdinand Berthoud, mechanist of the marine, member of the National Institute, and of the Royal Society of London. It contains a description of escapements, compensation balances, moving spheres, and of the principal inventions of clock-work. The author speaks of all the celebrated clock-makers, except Louis Berthoud, his nephew, to whom we are indebted for all the time-keepers made since 1784. I shall here take occasion to observe, that Mr. Emery died at London, and that his widow has four time-keepers which she wishes to dispose of: they would be a valuable acquisition.

We have received the 7th volume of the Transactions of the Royal Irish Academy, published in 1800, and in which Mr. Young examines the solution given by Newton of the problem respecting precession of the equinoxes; also the 8th volume of the Irish Transactions, Dublin 1802.

On the 18th of July my small tables of logarithms appeared: they are the most convenient and the most correct yet given.

The

The third volume of the *Mécanique Céleste* of C. Delaplace has been printed, and was published on the 29th of December. This work will form an epoch in physical astronomy. It exhibits a series of important researches by that great geometrican, and the perturbations of each of the planets by the action of all the rest; with a new theory of the moon, containing, besides other things, the discovery of a new inequality the period of which is 180 years, and of which I have already spoken.

M. Hassenfratz has published his *Cours de Physique Céleste*, or *Leçons sur l'Exposition du Systême du Monde.* He makes no mention in it of my Astronomy, but he neverthelefs has borrowed from it things which he could not find any where else. I have corrected some faults in it. (*Bibliotheque Françoise de Pougens.*)

The Board of Longitude has sent to the printing-office observations made for two years with the new instruments of the observatory by Mechain and Bouvard, to be printed in folio like those which Monnier published between 1751 and 1773, and those of Greenwich in England, which were worthy of serving as a model.

On the 3d of July M. de Rosel, a naval officer, arrived at Paris with the journals of the voyage undertaken in search of La Perouse, under the command of captain d'Entrecasteaux.

La Grandiere also has brought a journal of that voyage, which the English government had a year in their hands, but which they restored to him. At the depôt of the marine there are 58 charts constructed during that voyage by Beautemps-Beaupré, hydrographer of the expedition.

In the month of June I received intelligence from C. Bernier, who was at New Holland. Captain Baudin touched only in two places in an extent of 400 leagues which he traversed on the western coast. He was preparing to accomplish the remaining part of the expedition to the north and south: but it appears to me that the zeal of this astronomer has been thwarted by the indifference of the captain; and this voyage, on which we founded great hopes, will not be so productive as it ought to be.

The ship Lady Nelson, sent out with the Investigator, captain Flinders, which arrived at New Holland about the middle of December 1801, fell in with the Geographe, commanded by Baudin. She then found at Port Jackson the Naturaliste, commanded by Hamelin, and which failed about the middle of May to go in search of the Geographe, from which she had been separated by a gale of wind in the

Straits

Straits of Baſſe. Captain Flinders has ſent home his obſervations, and a chart of thoſe parts of New Holland which he viſited.

Captain Flinders made a diſcovery between Van Diemen's Land and New South Wales, of which information was received in March 1802: Governor King's Iſland, Cape Alban Otway, Portland Bay, Cape Northumberland.

Joſeph Joachim de Ferrer has ſent me ſeveral poſitions obſerved on the Miſſiſſippi and on the Ohio, which will be of the more importance as the French government is employed with the means of deriving benefit from that new colony, which may be attended with immenſe advantages, as Raynal has ſhown in his *Hiſtoire Philoſophique*.

The Voyage to the Northern Part of Aſiatic Ruſſia, the Frozen Ocean, the Sea of Anadir, and the Coaſts of America, from 1785 to 1794, by commodore Billings, tranſlated by Caſtera, in two volumes quarto, has made us acquainted with countries before undeſcribed or defined. The ſhores of the Kouſina have been traverſed: a chart by M. Bauer, and Arrowſmith, the Engliſh geographer, is added. The officers complain of the commander, who would not allow them to penetrate further north, notwithſtanding the inſtructions he had received to ſearch for a paſſage through the Frozen Ocean.

Travels into the interior Parts of Africa in 1797 and 1798, by Frederic Horneman, has been publiſhed. Horneman proceeded from Cairo to Mazoul. Another French edition, with additions by C. Langles, is in forwardneſs.

Geography has been enriched alſo by A Voyage to Senegal by C. Durand, one volume in quarto, with many plates. The author was a long time at Senegal; and I have mentioned his reſearches in a memoir on Africa.

M. Sutzen, a phyſician, accompanied by M. Jacobzen, a ſurgeon, is alſo preparing to penetrate into the interior parts of Africa. They have been furniſhed with obſervations by baron Von Zach, of Gotha. The duke of Gotha has given them a ſextant of ſeven inches radius, and a time-keeper by Emery; three artificial horizons, with their levels; an achromatic teleſcope of twenty inches, and two and a quarter inches aperture; a declination compaſs, a mariner's compaſs, and a camera obſcura.

M. Sutzen will proceed from Conſtantinople to the eaſtern coaſt of Africa, where he intends to join ſome of the caravans of Zinguebar or Monœmugi. He hopes to be four or five years abſent. (Von Zach's Journal for Auguſt 1802.)

On the 17th of July we ſaw don Domingo Badia, com-

missary of war in Spain, who travels by authority of the Prince of Peace, accompanied by Roixas, a naturalist. He will embark in England for Morocco, and will follow the route of the caravans of the interior.

Voyages à Madagascar, aux Indes Orientales, et à Maroc, by Alexis Rochon, a celebrated astronomer and geographer, have appeared in three volumes.

The general depôt of war at Paris continues its labours with surprising activity, as may be seen in the Moniteur of June 25 and October 16. Generals Calon, Clark, and Andreossy, who had the direction of it in succession, have been succeeded by general Samson.

The map of the country between the Adige and the Adda will soon be followed by maps of all Piedmont, of the Italian republic, and of the island of Elba: those of Bavaria, Helvetia, of the Valais, and of the four departments of the Rhine, are continued. More than a hundred geographical engineers are employed; among whom are the celebrated Nouet, Henry, and Tranchot.

On the 1st of July M. Henry quitted Bavaria, disgusted by the opposition of M. Bonne. The latter is still occupied with the map of Bavaria; but we lose the measurement of a degree, which M. Henry proposed to make. However, we shall have from the Scheldt to the Adige, and from Brest to Munich, an uninterrupted trigonometrical outline, which will soon be filled up with a complete topography. A map of Egypt in fifty sheets, and those of the Morea and neighbouring isles, are now engraving. Materials are collecting for maps of Saint Domingo and of Louisiana.

The beautiful map *des chasses,* a master piece of engraving, of which only five sheets were terminated, will be carried to thirteen.

A plan is even in agitation for making a new and correct edition of the large map of France in 183 sheets, which had been too much neglected. In the mean time, thirty are retouching.

The collection of manuscript charts at the depôt, which already amounts to 7400, daily increases. C. Barbier-Dubocage, already known by his important labours, turns them to the best advantage possible; and the depôt of war, encouraged by the government, is about to produce to geography immense riches.

The first number of a topographical and military memorial, edited at the general depôt of war, has been published for November 1802. It contains a notice respecting the geographical charts; a treatise on geodesic operations; tables for reducing

reducing the angles of one plane to another; the determination of heights by the barometer.

C. Nouet, who arrived from Egypt on the 5th of January, has already set out for Mount Blanc, where he will continue the laborious operations which he began in 1796.

The Russians are going to construct a map of Esthonia and Volhynia.

M. Weiss has terminated his map of Swisserland in sixteen sheets.

A beautiful chart of the southern part of the geometrical survey, by captain Mudge and Mr. Dalby, has been engraved in England in four sheets.

M. Ciccolini has made a tour to the coasts of the Adriatic, where he has verified the positions of a great number of points. In regard to Pezaro there was an error of 30″ in time.

The travels of baron Von Zach, so useful to the geography of Germany, are detailed in the excellent journal which he publishes every month.

M. Mentelle has undertaken for the First Consul a terrestrial globe a metre in diameter, which will contain all the new discoveries collected with great care and erudition.

On the 26th of March I obtained permission to found at the Institute a prize, to be assigned to the person who, in the course of the year, shall make the most curious observation, or publish the most useful memoir, in regard to astronomy.

C. Chaptal, whom we have the good fortune to have for minister of the interior, and whose labours as a philosopher announce his zeal as a minister, has attached calculators to the Board of Longitude; he has granted gratifications to C. Flaguergues, an assiduous observer, and to C. Pons, keeper of the observatory of Marseilles, who discovered a second comet.

When the consultation established for distributing rewards, and which was very useful in 1793 and 1794, was suppressed, the Institute was charged to take up the same business, and to propose to government the gratifications it would be necessary to give. The Institution has not yet exercised this right, but I have proposed to it to fulfil its obligation.

M. Jacotot, professor of astronomy at Dijon, has obtained from C. Giraudet, prefect of La Côte-d'or, the repairs necessary for the observatory damaged by a fire. I hoped I should have been able to observe there the eclipse of the sun on the 28th of August: but the sky was absolutely cloudy, as it was at Paris. We have received observations of that

eclipse from C. Thulis at Marseilles, and from C. Flaguergues at Viviers.

Prince Henry of Wirtemberg, brother of the empress dowager of Russia, who resides at Hamburgh, has purchased the beautiful instruments made by Megnié, of Paris.

The speculum for a telescope, which Dr. Herschel sent to Petersburgh, has been sent back to him for the purpose of being mounted. Kramp solicits for the establishment of an observatory at Cologne.

The academy of Turin requests the re-establishment of its observatory; and M. Henry has offered to take the direction of it.

Fathers Canovai and Delricco, who have at Florence the observatory of father Ximenes, have sent us a list of their instruments, to prove that they cannot exert themselves with any advantage for astronomy; but they have published tables of logarithms.

The king of Etruria has announced that he still entertains a design of placing an astronomer in his *Cabinet de Physique*, where he has already some excellent instruments.

General Chabert, who has returned from England after an absence of ten years, has been associated with the Board of Longitude, to which office he was justly entitled by his geographical labours; and his age of sixty-eight years does not prevent him from being present at the sittings, and from being useful by his advice and experience.

The youngest son of our celebrated astronomer C. Mechain has been appointed by the Board of Longitude secretary of the observatory, which affords him an opportunity of devoting himself to astronomy. Augustine Francis Mechain was born at Paris, March 5, 1786.

He has succeeded his brother Isaac, who having returned from Egypt has been appointed commissioner of foreign relations at Galasia, in Moldavia.

C. Lechevalier has constructed in the Hotel of Foreign Relations a small observatory, where he can gratify the taste and curiosity of which he gave proofs during his stay at Constantinople.

C. Louis Berthoud has constructed for the observatory a clock worth a thousand crowns. The pivots turn in rubies, and we hope it will equal that given by the First Consul to the observatory of Milan.

C. Pons, a watchmaker of great skill and ingenuity, made an experiment at my observatory of a clock which beats half seconds with a free scapement, and which goes with wonderful regularity.

C. Levêque

C. Levêque has publifhed, in the fourth volume of the Memoirs of the Inftitute, a learned paper on the longitude, and particularly on Maignon's charts for reducing the moon's diftances obferved at fea.

C. Richer has made a new trigonometric compafs, or compafs for reducing the moon's diftances from the ftars. It has ingenious inventions for dividing into unequal parts the rules containing the diftance, the fum, and the difference of the heights. In my fhort Treatife of Navigation I have given a defcription of the inftrument which gained the prize in 1791; and in the *Connoiffance des Temps* for the year 4, the demonftration of the formula of M. de la Grange, which ferves as a foundation for this inftrument; which, however, has been much improved: the only inconvenience is, that it will coft 600 francs.

Mr. Troughton has finifhed the model of Menoza's circle, which gives the double of the multiple of Borda's circle, even retaining the fmalleft fixed mirror.

A curious detail refpecting the calendar of the Indians has been publifhed in the letters of the abbé Sevin.

C. Girard read in the Inftitute a long memoir on the Egyptian milometer, the value of which he determined in the ifland Elephantine, on the very fpot, 19 feet 5·6 lines; which fhows that the antient meafurement of the earth by Eratofthones was very correct.

The abbé Tefta has publifhed at Rome a differtation on the zodiac found at Dendara (in Greek, Tenthyris) in Egypt. He undertakes to prove that it is not older than 300 years before the vulgar æra. The Hiftory of Herodotus, tranflated by Larcher, edition of 1802, contains a fally againft the unbelievers, who carry back the period of one of the zodiacs of Tentyra, at prefent Dendera, and of Efné, or Henne, to 6000 years; and the author's only reafon is, that it would be 217 years before the creation.

He adds a notice by Vifconti, who fays that the firft fign of the great zodiac is Leo; that Libra, the fymbol of the equinox, is in its place; and that the refemblance of the greater parts of the figns to the Grecian proves that this zodiac was conftructed at a time not fo remote as the earlieft periods of the Greek aftronomy: he is almoft convinced that this work belongs to the firft century of the vulgar æra.

The exterior cornice exhibits a large Greek infcription, which may decide the queftion; but another Greek infcription contains Roman names, and announces a Cæfar, who could be only Auguftus or Tiberius. In a word, M. Vifconti fays that the architecture of the temple of Tentyra, though in

the Egyptian taste, and though some hieroglyphics are carved out on the walls, has an evident relation to the arts of Greece. For my part, I have remarked by the engraving of M. Denon that Cancer is inscribed in two lines, at the beginning of the descending signs and at the end of the ascending; which proves that the solstice was towards the middle of Cancer; and this carries it back 3000 years. But I have shown in my Astronomy that Eudoxus, who wrote 370 years before our æra; and Aratus, who followed Eudoxus, described the sphere according to an older tradition, which goes back twelve or thirteen hundred years before the vulgar æra, and which came from Egypt or India. Petau, Whiston, Freret, and Legentil, found nearly the same date: it is therefore natural to believe that it should be found in the zodiac of Tenthyris, which consequently, in this respect, may be considered as a work of the Greeks.

C. Villoison, well known by his Greek erudition, has celebrated astronomy in Latin verses, which announce both his talent for Latin poetry and his taste for astronomy. He addressed them to me on my birth-day, and published them in the *Magazin Encyclopédique*. In the notes he speaks of the labours of the uncle, the nephew, and niece; and of citizen Burckhardt, their most learned co-operator and their most intimate friend.

C. Boulage, of Troye, has written a beautiful epistle to Piazzi on the discovery of his planet: it has been inserted in the fourth number of the Memoirs of the Academical Society of the department of Aube.

Astronomy this year has lost the respectable Augustin Darquier, member of the National Institute. He was born at Toulouse, November 23, 1718, and died on the 10th of January 1802. He devoted himself early to astronomy through natural inclination. Though in a town distant from the capital, he applied to it with a zeal and activity which were not lessened by age. He purchased instruments, established an observatory in his own house, and caused two volumes of observations to be printed at his own expense. His translation of Lambert's Cosinologic Letters has been printed at Amsterdam. He instructed pupils, paid calculators, and being in no need of the assistance of government he was indebted for every thing to himself. I have printed his last observations in my *Histoire Céleste*; they go as far as the 19th of March 1798; and he had some more to send me, though 80 years of age. The Lyceum of Toulouse will give us some further particulars respecting his long and interesting career.

Astronomy

Astronomy lost also in France, on the 1st of March, M. Lemery, whose singular turn for calculation I discovered thirty years ago. Being then attached to the marquis De Pusieux, he employed all his leisure time in calculation. I made him calculate a great many places of the moon, which were published in 1777 in the *Connoissance des Temps* for 1779: and for fifteen years he made all the calculations of that work with equal care and assiduity.

Daniel Bogdanich died at Pest, in Hungary, on the 31st of January, at the age of 37. He was occupied with the geography of Hungary. (See Von Zach's Journal for April 1802.)

M. George Frederic Kordenbusch, astronomer of Nuremberg, died on the 3d of April, at the age of 71.

In the month of September baron De Vega was drowned in the Danube, and it is supposed threw himself into that river. We are indebted to him for the large edition of Vlacq's tables of logarithms in folio, containing the numbers to 100,000; and the sines from ten to ten seconds, which had become very rare, and in which he corrected many faults.

Meteorology has this year exhibited very extraordinary phænomena. In the month of January an extraordinary inundation: the Seine rose 22 feet and a half above the height of 1719.

On the 25th of May a frost, which did immense hurt to the productions of the earth.

On the 14th of May snow fell at Munich, and continued for forty-five hours: the trees were stripped of their leaves, and overturned.

In the months of July and August an excessive heat took place, and continued forty days. The thermometer at the observatory stood at 97° F., which is very uncommon at Paris.

The need of having meteorological rules founded on observation, induced our learned minister to establish a correspondence on that subject, and an office to conduct it.

Meteorological observations have been made in thirty places, from the convent of Mount Cenis as far as the borders of the sea.

John Dominic Beraud, born in 1741, formerly a draftsman at Coni, and who for twenty years has resided at Turin, continues to employ himself in making meteorological observations, and sends us regularly his results.

Lafon, geographical engineer in Louisiana, has sent us meteorological observations made at New Orleans; and we have received some made at Guadaloupe by C. Hapel Lachenaye

chenaye between the years 5 and 9. The fourth volume of the Memoirs of the Institute contains some also.

C. Coulomb read in the Institute experiments on the method of magnetizing needles to saturation; with a comparative view of the methods of Knight, Duhamel, and Æpinus. He has pointed out to navigators the surest means of obtaining the best needles. The broadest and largest are preferable, but they must not be thick. This philosopher has published in the fourth volume of the Institute a curious memoir on the dipping needle.

The declination of the magnetic needle at Paris was observed by C. Bouvard at the observatory, on the 2d of May, to be 22° 3′, and on the 22d of July 21° 45′.

C. Lenoir, at the Garden of the *Depôt de la Marine*, found it on the 20th of June to be 22° 6′ with a compass, on which he employed every care possible. But the changes which take place at the different hours of the day, and in different months of the year, amount to more than 10′. We can therefore only say that the declination is 22°, and it was found to be the same in 1792 and 1800; so that at present it appears to be stationary, whereas ten years ago it increased from 6′ to 8′ annually.

Forty years ago I observed it to be $18\frac{1}{4}$°. (See *Connoissance des Temps* for 1762.)

M. Simonin, professor of Croisic, has sent us the result of a thousand observations on the tides, with the tables necessary for keeping an account of the variations produced by the sun and moon according to their altitude and distance.

M. Romme, professor of Rochfort, has sent to the Institute observations made every three minutes from low water to full moon to make known the irregularities, which are very singular; and a new table of the retardation of the tides, deduced from an immense number of observations.

He has presented also a general table of the tides, the currents, and winds, observed in all the seas of the earth; the publication of which will form an important supplement to the large Treatise on the Flux and Reflux of the Sea, which I published in 1781.

Mr. Grenier, an officer known by his discoveries in the Indian seas, has written a considerable work on the winds and currents in all the seas; with a theory which renders the explanation of them easier. He proposes to lay it soon before the public.

XXXVIII. *On*

XXXVIII. *On the Disappearance of Saturn's Ring in the Year* 1803. *By Professor* J. E. Bode*.

THE plane of Saturn's ring, as is well known, during the whole of his revolution of thirty years round the sun, retains its parallelism, and intersects the plane of the ecliptic in 17 degrees of Pisces and of Virgo at an angle of 31½°. The necessary consequence, therefore, is, that the northern side of the ring is illuminated for fifteen years by the oblique rays of the sun, and then the southern for the same period. It must also happen, that in the above places the plane of the ring passes twice through the sun in each revolution, at which time the edge of the ring only is illuminated. But the edge or thickness of the ring being too small to admit of its being seen from the earth on account of the great distance of Saturn, the ring becomes invisible. For fifteen years the earth and the sun are on the same side of the ring, which is the illuminated side, and therefore the ring during that period is always visible; but a little before, and at that period when the plane of the ring passes through the sun, or when Saturn's heliocentric place is in 17° of ♓ or of ♍ in the ascending or descending nodes of the ring, the earth and the sun may first be on one side and then on the other side of the ring. In the first case, as long as its plane does not pass through the sun it will be visible from the earth; but in the other case it will be invisible. The earth, therefore, can then pass several times through the plane of the ring, at which time the ring will appear like a right line, or be entirely invisible; the consequence of which is, that the ring will be alternately visible and invisible.

This alternation of disappearing and reappearing will be exhibited by the ring in the year 1803. The sun, having illuminated the south side of the ring since October 1789, will pass through the plane of it in the month of June 1803, and will illuminate the northern side, when Saturn passes heliocentrically the ascending node of his ring; and in the mean time the plane of the ring will pass three times through the earth, which will be first on the side illuminated by the sun, and then on the opposite or darkened side; in consequence of which the ring seen from the earth will be twice visible and invisible in the course of a few months.

These phænomena will be better comprehended by inspecting the annexed figure, which supposes the observer to be placed

* From his *Astronomisch Jahr Buch* for 1803.

placed in Saturn. This figure, then, exhibits the exact inclination of the plane of the ring to the ecliptic; the apparent motion of the earth and the sun, as seen from Saturn, together with the time of the passage of these planets through the ascending node of his ring. (See Plate V. fig. 2.)

AB is the ecliptic seen from Saturn in the sign of Pisces, and divided into degrees. The ascending node of Saturn's ring seen from thence is placed in 17° 6′, in which point the plane of the ring intersects the ecliptic at an angle of 31° 20′. The eye is then in that plane. Thus the ring appears as a straight line; *nn* is the north side, and *zz* the south side of it. The dotted line CD is the solar orbit seen from Saturn; and the sun's place is marked in it on the first day of each month, from November 1802 to October 1803. These places of the sun are directly opposite to the heliocentric places of Saturn: the longitude thus differs six signs, and the northern latitude of Saturn seen from thence changes into the southern of the sun. In this manner, the sun in November, December, January, and to the month of June, illuminates the south side of the ring; but always in a fainter manner, the nearer he comes to the plane of it. On the 15th of June he passes through the plane in *e*. The ring at that time is illuminated on the edge, and can be seen only by powerful telescopes as a fine luminous line.

The longitude of the point *e*, reduced to the ecliptic, falls in *f*, or 20° 42′ of Pisces. The sun, then, about the middle of June begins to illuminate the northern side of the ring; in July, August, September, October, &c. he recedes more and more from the plane of the ring, and the illumination of it then becomes stronger.

The elliptical line is the earth's orbit as seen from Saturn, according to its direct and retrograde motion from the 1st of November 1802 to the 1st of October 1803, and its place is marked on the first of each month. Its longitude is six signs less or more than the geocentric longitude of Saturn; and the northern latitude of Saturn is changed into the southern of the earth.

Now, as the figure clearly shows, the earth in November and December 1802 is represented on the south side, or turned towards the sun, and therefore on the illuminated side of the ring. But afterwards the earth approaches more and more to the plane of the ring; and, as the ring receives the solar rays in a more and more oblique manner, the ring not only becomes narrower but even decreases in light. On the 13th of December, as may be seen by this small figure, the earth enters the plane of the ring, and passes to the

northern

northern ſide of it, which is turned from the ſun. The ring then, for the firſt time, becomes to us inviſible: but this inviſibility is not of long continuance; for, as may be ſeen by the figure, the earth on the 1ſt of January, by its Saturniocentric apparent retrograde motion, paſſes a ſecond time through the plane of the ring, and goes to the ſouthern or illuminated ſide, and the ring then begins to appear again as a ſtraight line. In February, March, and April, the earth recedes more and more from the plane, and the ring becomes broader and more perceptible. But the ſun during theſe months approaches nearer to the plane of the ring, and by theſe means it is illuminated in a more oblique direction. In the month of May the earth is at its greateſt diſtance from the plane of the ring, while the ſun approaches it more and more till the middle of June, when he paſſes through the plane in *e*, and the ring for the ſecond time becomes totally inviſible to the earth, which is then on its dark ſide. From this period, during the month of July and till Auguſt, the ring will remain in this ſtate. About the 18th of Auguſt the earth will paſs, for the third time, through the plane of the ring, as it will then be on the northern, which is now the illuminated ſide of the ring: it will again appear as a ſtraight line, and be viſible when viewed through good teleſcopes: it will increaſe in light and breadth in September and October in proportion as the earth and the ſun recede from the plane.

Between the 1ſt of November 1802 and the 1ſt of October 1803 the ring of Saturn twice diſappears and twice reappears. At the firſt diſappearance on the 13th of December 1802, Saturn in the morning will be in the eaſtern part of the heavens; and the firſt reappearance will be about the 7th of January 1803; Saturn in the night-time being on the ſame ſide of the heavens.

At the ſecond diſappearance in the middle of June, Saturn in the night will be in the weſt, and, as he ſets half an hour after midnight, the phænomenon may be obſerved. But at the ſecond and laſt diſappearance in Auguſt, Saturn will be after the ſun, and therefore the phænomenon cannot be ſeen. In the month of October, when Saturn emerges from the ſun's rays, he may be ſeen before ſun-riſe in the eaſt, and the ring then will be very viſible.

In regard to the above calculation of the times of the diſappearance and reappearance of Saturn's ring, the accuracy of them, and the correſpondence of them with the phænomena, muſt depend on the accuracy of the tables and the theory hitherto adopted in regard to the poſition of the ring.

 The

The ſtate of the atmoſphere alſo, and the different power of the teleſcopes and of the eyes of the obſervers, may occaſion ſome variation. The diſappearance and reappearance of the ring, which are occaſioned by the earth paſſing through its plane, can be better and more conveniently obſerved than thoſe which take place in conſequence of the paſſage of the ſun through that plane, becauſe the earth, on account of its quicker motion, paſſes ſooner through the plane of the ring than the ſun.

As the ſix firſt ſatellites of Jupiter move in the ſame plane with the ring, when the ring diſappears, or becomes like a luminous line, theſe ſatellites muſt appear on both ſides of Saturn in a right line, and can then be more readily diſcovered and diſtinguiſhed from fixed ſtars.

XXXIX. *On the Disappearance of the Ring of Saturn.* By Van Beeck Calkoen, *Profeſſor of Aſtronomy at Leyden* *.

THE plane of Saturn's ring, according to aſtronomical obſervations, has always a direction parallel to itſelf, ſo that it interſects the ecliptic in 17° 18′ of ♍ and ♓, at an angle of $31\frac{1}{2}$°, and the orbit of Saturn at 20° 42′ of ♍ and ♓. Now, if Saturn as ſeen from the ſun be in longitude 20° 42′ of ♓, the plane of the ring will paſs through the centre of the ſun; by which the edge of the ring being illuminated, while the northern and ſouthern ſurface receive no light, it muſt become inviſible, and can be ſeen only by the moſt powerful teleſcopes as a fine luminous line. On the 15th of June next Saturn will be in this ſituation; and as this planet employs about thirty years in its revolution round the ſun, this phænomenon takes place only once in 15 years. Other phænomena, however, in conſequence of which the ring before the 15th of June will alternately diſappear and reappear, are connected with this ſtate of the planet. Theſe phænomena ariſe from the different poſitions of the earth, which in the courſe of its revolution is at one time above and at another below the plane of the ring; ſo that from the 1ſt of November 1802 to October 1803 the ring will be twice inviſible and twice viſible; firſt the ſouthern and then the northern, then the ſouthern and afterwards the northern ſurface will be alternately ſeen from the earth within the courſe of ten months. For determining and calculating theſe phænomena with more accuracy, Lambert in-

* From *Algemeene Konſt en Letter-Bode*, No. 13, for 1803.

vented

vented a very ingenious kind of projection, a repreſentation of which was given by profeſſor Bode, of Berlin, in his Aſtronomical Almanac for 1789, in which year theſe phænomena took place in the ſame manner as they will do in 1803; and this repreſentation has been repeated in the ſame work for the preſent year: but as this diagram, in my opinion, is too difficult for thoſe not well verſed in aſtronomy, I flatter myſelf that the following figure will render the phænomenon eaſier to be underſtood by amateurs; though Lambert's method is more exact, and better ſuited to aſtronomers.

The circle (Plate IV. fig. 1.) repreſents the earth's orbit, and exhibits the points where the earth is placed at the commencement of each month. The vernal equinox is marked o ♈, the line SZ drawn through the ſun; and the place of Saturn on the 15th of June is the direction of the plane of the ring. Saturn, at the four periods announced, is in the lines drawn parallel to SZ, though at a diſtance from the ſun five times greater than is here repreſented for want of room. The plane of the paper is that of the ecliptic, with which the one-half of Saturn's ring makes an angle of 31°.

I have already obſerved that the ring twice diſappears, and then twice becomes again viſible. This phænomenon ariſes partly from the ſituation of Saturn in regard to the ſun, and partly from that of the earth; and each of theſe cauſes muſt be conſidered ſeparately to have a clear idea of theſe phænomena. In regard to the firſt, it is evident that that ſide only of Saturn's ring which is turned towards the ſun can be illuminated; and this illumination is ſtrongeſt when the planet is in 20° of ♊ and 20° of ♐, the whole ſurface of the ring being then oppoſite to the ſun. Now as the direction of the ring is always the ſame, that is to ſay, parallel to itſelf, the rays of the ſun, as the planet approaches to 20° of ♍ and ♓, muſt fall more obliquely on the ring, by which means it will be more faintly lighted, and at the ſame time appear ſmaller; and when Saturn has attained to this longitude, no part of the upper ſurface, but merely the edge of the ring, the plane of which paſſes through the ſun, will be illuminated; ſo that the ring will then have the appearance of a thin luminous line, but will not be viſible without the help of good glaſſes. For the laſt ſeven years the ring has been obſerved to decreaſe in light and in breadth; and this decreaſe will continue till the 15th of June, after which both will again increaſe. During the laſt fifteen years the ſouthern ſurface of the ring has been illuminated, but in the next fifteen the northern ſurface alone will receive the rays of the ſun. In whatever part of our ſolar ſyſtem this phænomenon

non be viewed, the appearance will be the same. The ring till the 15th of June will continually become smaller, and on that day will be converted into an almost imperceptible line of light. The disappearance then of Saturn's ring on the 15th of June, or rather its decrease till that period and its subsequent increase, arises alone from the relative position of Saturn and the sun. As to the other causes of disappearance, which are the consequence of Saturn's position in regard to the earth, we must first keep in view the slow motion of Saturn compared to that of the earth, as this planet advances scarcely 12° in the time that the earth performs its revolution around the sun. On the 15th of June, at which time Saturn will be in 20° of ♓, and the plane of the ring will pass through the sun, the intersection of that plane with the ecliptic, or the line ZS in the figure, passes through the middle of the earth's orbit. During the last fifteen years, while Saturn advanced from ♈ to ♍, this line of the plane of the ring was without, and above the earth's orbit, and during that period the southern and luminous part of the ring was always visible; but about the middle of December 1802 this line approached the earth's orbit, and on the 13th of December passed through it exactly in the point where the earth then was. The earth being then in the plane of the ring, the thickness of the ring only could be visible to us; and thus, for the first time in fifteen years, disappeared on the 13th of December 1802. On the other hand, as the earth moved straight towards Saturn, or parallel with that line, while Saturn advanced, it was necessary that the southern surface of the ring hitherto visible should become invisible, and the northern, which was not illuminated, being turned towards the earth, the whole ring would become invisible. But as the earth proceeded in its orbit it would soon reach the line of the plane, and on the 7th of January 1803 would again pass through it. At that period, the southern surface of the ring being illuminated by the sun would again be visible from the earth; but as the earth on the 21st of June must in its revolution be again on the other side, Saturn in his course falling in with the earth in the plane of the intersection of the ring and the ecliptic, will again pass through it on the 18th of August, at which time the ring will appear once more as a fine stripe of light. After that day the northern surface of the ring will be visible from the earth, and, as the line of the plane will then be without the earth's orbit, will, during the next fifteen years, remain always visible.

From the 7th January to the 21st of June, the southern surface of the ring being illuminated, the ring will be visible; but

but from the 21st of June to the 18th of August no part of it will be seen, as its darkened side during that period will be turned towards the earth. This disappearance and reappearance of Saturn's ring will be of importance to astronomers, as it will enable them to determine the direction of the plane of the ring, and will afford a curious spectacle to amateurs who are provided with good telescopes. The ring, which already appears as a broad stripe of light, will continually become smaller till the 15th of June; after which time it will disappear till the 15th of August, when it will appear as a fine stripe of light, which will increase in breadth till the aperture between it and the planet will increase during the first seven years. As Saturn till the month of June sets at midnight, the decrease of the ring may always be observed; but when he sets earlier it will be possible to see him only a short time in August, as he will be lost in the sun's rays.

Leyden,
March 10, 1803.

XL. *Memoir on the Fossil Caout-Chouc, or Elastic Bitumen of Derbyshire.* By FAUJAS-SAINT-FOND*.

ABOUT twenty years ago some insulated portions of a kind of blackish bitumen, compressible and even elastic, which had some sort of resemblance to old leather, were found in the natural fissures of one of the mines of Castleton. The young miners having set fire to some of this matter, it burnt with a bright flame, emitting an odour which did not appear to be disagreeable.

At that period mineralogy was not so well known as at present in England, and particularly in Derbyshire: no one paid attention to this fossil, or endeavoured to ascertain its nature.

Twelve years after, a heavy storm of rain having produced a deep ravine on the side of one of the hills which surround the village of Castleton, a similar kind of bitumen was found between the fossil strata of argillaceous schist which exists at the bottom of that hill.

More care was then taken to collect this matter, some of which was sent to Derby, Edinburgh, and London; and so great a relation was found between it and the *caout-chouc*, known under the vulgar name of *elastic gum*, that mineralogists did not hesitate to consider it as the same as that brought

* From *Journal du Museum National*, No. 4.

from Guiana and Peru. This opinion was soon confirmed by chemical analysis; and this singular fossil was the more sought after, and considered as a curious object of natural history, as it was more rare; and as it was thought an astonishing circumstance, that a substance which distils from exotic trees which grow only in the torrid zone should be found between strata of argillaceous schist in the bosom of the mountains in the northern part of England.

Lametherie mentioned this discovery in the *Journal de Physique*, without giving any details respecting the place where it was found: he only insisted on the analogy between this fossil bitumen and the caout-chouc.

At that period some varied fragments of this substance were sent to me, together with the matrices in which they had been found; and as I was acquainted with the places and the mountain where the discovery had been made, I mentioned this important fact every year in my geological lectures at the Musæum, when I treated of the exotic wood and plants found in a fossil state in countries absolutely opposite to those where these plants and trees grow at present: but I published nothing on the subject, as has been observed by Mr. Mawe, proprietor of the principal mines of sparry fluor of the neighbourhood of Castleton, and author of *The Mineralogy of Derbyshire*, lately published; a work which will be exceedingly useful to naturalists who intend to visit that county, so abundant in a variety of mineral productions *.

Mr. Mawe, when last at Paris, brought me some very remarkable specimens which were wanting in my collection of fossil caout-chouc; and it is my duty to acknowledge here my gratitude to him. He was so kind as to give me also some information on this subject; and he showed me at the same time a piece of fossil caout-chouc, discovered not long ago, consisting of an oblong mass two feet and a half in circumference and two inches and a half in thickness, weighing about three pounds. It is soft, exceedingly compressible, and of a black and somewhat olive colour; solid, hard, and shining fragments of a bitumen nearly similar are enveloped by, and adhere as it were to, the elastic mass, both in the inside and on the exterior faces. They are not larger than a common almond; some of them are *black like jet*, others of a *brown liver* colour. They may be easily detached from the compressible caout-chouc where these hard fragments are not abundant.

* The Mineralogy of Derbyshire, with a Description of the most interesting Mines in the North of England, in Scotland and Wales. By John Mawe. London 1802. 8vo. one volume, with plates.

Mr.

Mr. Mawe has made known in his Mineralogy of Derbyshire the principal varieties of the fossil caout-chouc; but as he has attended rather to those select specimens fittest for ornamenting collections, than to a systematic description of these pieces as well as of the matrices which accompany them, and as he thought it of no use in his plan to enter into details respecting the nature and depth of the places where the fossil caout-chouc is found, I shall supply the deficiency in this part, which is so intimately connected with geology.

In order to give a topographical idea of the place, I shall observe, that in going from Derby to Castleton you are obliged to ascend a pretty rapid acclivity to a large plain in the form of a mountain, which extends for several leagues in every direction. All this elevated, rugged, and rocky district is known by the name of High Peak. It is in general calcareous, and even abundant in shells, except some argillaceous strata, and particularly several veins of trapp which intersect transversely the calcareous strata, or which, disposed sometimes in banks, proceed nearly parallel with beds of limestone. I shall say nothing of the veins of lead ore, of the beautiful crystals of sparry fluor, of the calamine and other minerals found in this district. For an account of these I shall refer to the Description of Derbyshire, Whitehurst on the Formation of the Earth *, and Ferber's Oryctographia of Derbyshire †, or that which I gave myself of the environs of Buxton and of Castleton in my Tour through England and Derbyshire ‡.

Castleton is not seen till you are, as I may say, above it, and till you arrive at the edge of a rapid and steep declivity, which intersects, in an abrupt and sudden manner, this part of the mountain surrounding the bason, at the bottom of which the small village in question is situated as in the middle of a funnel.

The revolution which divided this mountain, by tearing asunder its sides, arose, no doubt, from one of those grand natural events similar traces of which are to be found even in the High Alps; but here this terrible commotion, by opening the bosom of the earth, has uncovered several mineral riches which without this accidental circumstance would never have been known.

* Inquiry into the Original State and Formation of the Earth, &c. by John Whitehurst. London, 4to. with plates.

† Essay on the Oryctography of Derbyshire, by Mr. Ferber, translated from the German.

‡ Voyage en Angleterre, en Ecosse et aux Iles Hébrides, &c. 2 vols. 8vo. avec fig.

One of the precipices of this mountain is known by the name of Hay Cliff: it is calcareous, and contains shells and other marine productions in a state of petrification. The other is called Man-Tor: it is also calcareous, and towards the foot there are some galleries of a mine, on a vein which terminates near the surface, and of which the matrix is a milky calcareous spar containing large-grained galena, but in small quantity. There are found also towards the bottom of the same precipice, as well as in some other parts, fissile strata of argillaceous schist, very often marly, which imbibe water in the time of rain, split, and occasion the solid and stony masses which rest above them to crumble down*.

Some of the schistous strata in question have a certain hardness; but all in general have a character of alluvion which an experienced eye cannot mistake, and yet their formation is of the highest antiquity. It is at a depth which, without fear of being deceived, may be estimated at least at four hundred and fifty feet below the upper stratum, that the fossil caout-chouc has been found, and particularly the large fragment in the possession of Mr. Mawe. In general it is in small cavities, in a kind of nests between the fissile strata, that this bituminous matter is contained; and as in this state it is sheltered from the action of the air, it needs excite no surprise that it should have experienced only very little alteration, and that its nature is not changed.

In the last place, one of the cavities, twenty-two inches in length and five inches in height, contained a great deal of caout-chouc. By these means very fine specimens of it may be obtained for collections, at a very moderate price; and it is to Mr. Mawe that we are indebted for this obligation. This gentleman, who with his father-in-law Mr. Brawn possesses a large manufactory of sparry fluor, of which they make elegant vases and other ornaments, carries on trade in a very honourable manner with the minerals of Scotland, Derbyshire and other parts of England, a depôt of which he proposes to establish at Paris, which must, no doubt, be of advantage to the progress of mineralogy.

I divide the fossil caout-chouc of Derbyshire into elastic or compressible bitumen, and solid, hard, and brittle bitumen.

* "The earth and stones which crumble down from this mountain," says Ferber, who visited these places several years before I did, "form in several places small hills, the size of which daily increases, and which the people consider as one of the seven wonders of the Peak."—*Essai d'Oryctographie du Derbyshire*, par Ferber, *Trad. Francoise*, p. 21.

SECTION

Section I.

Compressible Bitumen.

Variety I. Elastic bitumen of a blackish brown and somewhat olive colour, soft, exceedingly compressible, unctuous and somewhat fat, of a slightly aromatic smell, but having a little of the insipid odour of natural caout-chouc; inflammable, and burning with a bright brilliant flame, leaving a black oily residuum which does not become dry. The fragments of this variety are sometimes an inch and a half in thickness and four inches in breadth. They are the largest except the fragment in possession of Mr. Mawe, which is considerably larger.

Variety II. Fossil caout-chouc, split and cracked in the whole exterior surface, which was in contact with the matrix from which it has been detached. It is dry in that part, but nevertheless compressible; black on the surface exposed to the contact of the air; but remarkable in this respect, that when a lamina of about a line in thickness is cut from this caout-chouc with a very sharp knife, it appears in the inside of a yellowish white colour: when cut in a very thick part, where the action of the air has not been able to render it black, like certain balls of the elastic gum brought sometimes from Para, it has the same appearance as the usual caout-chouc. Another circumstance worthy of attention is, that in the part recently cut a kind of acid matter is observed to ooze out, which is not of a disagreeable taste, and which appears to be of the nature of the pyrolignic acid. This caout-chouc is pellucid on the edges, and almost of a hyacinth red colour.

Scarcely has the air exercised its action on the part recently cut, which is white, when it assumes a slight reddish tint, which daily becomes darker, and acquires a dark mahogany and then a blackish brown colour; at length, at the end of a month, if exposed to the air, it becomes of a deep black.

Variety III. The same caout-chouc as the preceding, but of a somewhat firmer texture and a ligneous appearance. When viewed with a magnifying glass, it is observed that the fibrous undulations seen in this variety are merely the effect of the milky substance which flowed from the tree more or less slowly or at different times, and which did not acquire consistence till it had lost the mucilaginous water which held the matter of caout-chouc suspended or in solution. I particularly mention this fact, to show that this variety has no real relation to the wood of the tree which produced at that period the elastic bitumen.

Variety IV. Fossil caout-chouc, compressible, and having a relation to the first variety, but of a darker colour, adhering to gray calcareous spar mixed with some grains of galena.

Variety V. Caout-chouc of a liver brown colour, much less unctuous to the touch than the first variety, but compressible, and having the aspect of the real natural elastic gum; and the more remarkable, as it is found to become solid, as we may say, in some parts, where it acquires a much greater hardness, and even becomes brittle, and acquires a vitreous splendour. This gradual change is so striking, that we cannot consider this hard bitumen, which in the present specimen is of a yellowish colour, as a hard bituminous matter accidentally enveloped by caout-chouc.

SECTION II.

Solid and Brittle Fossil Caout-Chouc.

No. VI. Black solid caout-chouc, hard and brittle like jet, exceedingly brilliant on its fracture, which is conchoid, and sometimes finely marked with striæ disposed in the form of rays, proceeding from the point of fracture, and expanding in the manner of a fan; electric by friction, opake throughout the whole mass, but pellucid at the edges, and particularly when viewed in a strong light: its colour is then a red, almost as bright and agreeable as that of the hyacinth, and analogous to the colour observed on the edges of the elastic caout-chouc of the second variety, seen in the light which seems to announce their identity.

No. VII. Another variety of hard caout-chouc, similar to that of No. VI. in hardness and splendour, but which is of a liver brown colour. It is entirely pellucid by the light of a lamp even throughout its whole substance, though opake in common day-light, and its colour is then similar to that of the hyacinth.

No. VIII. The same variety as the above, but of a paler liver colour. It has besides the same characters and the same properties as the other hard and brittle kinds of caout-chouc; but it is remarkable for still adhering to its matrix, consisting of semi-transparent milky calcareous spar, with thick brilliant laminæ of galena. The caout-chouc here not only adheres to the calcareous spar but to sulphurated lead, and is intimately mixed with both.

Mr. Mawe, in his Mineralogy of Derbyshire, mentions the following very curious fact:—" A variety, the only one I possess of the kind, is elastic bitumen in a petrified marine shell inclosed in the rock;" also " another specimen no less rare

rare is obscure caout-chouc, but transparent in the light, inclosed in crystallized fluor." Fossil caout-chouc, according to Mr. Mawe, is found also in sulphated barytes.

If it be considered that trees and other vegetables, which produce natural caout-chouc in such abundance that the matter can flow down and accumulate at the root of them when the wind or any other accident lacerates the bark or breaks the branches, are all exotic, it will be allowed that this is a curious geological fact, which coincides with that of fossil amber, which has been found, and is still found, in some coal mines, and in turf soil of an antique origin, and which differs from that formed in the common turf mosses. We are not yet acquainted with any vegetable productions which furnish caout-chouc in abundance, but the following:

1st, The *vahea*, a species of apocinea, which grows in Madagascar, and of which Lamarc has given a figure in his *Illustrations de Botanique.*

2d, The *urceola elastica* of Sumatra and of Pullo-Pinang, discovered by Mr. Howison, an English surgeon at Pullo-Pinang, and described in the fifth volume of the *Asiatic Researches* by Dr. Roxburgh *. This plant is of the family of the apocineæ.

3d, The *hevea Guianensis*, described and exhibited in a figure by Aublet in his *Plantes de la Guiane*, is a large tree of the family of the euphorbia. It rises to the height of more than forty feet; its trunk is sometimes above two feet in diameter; and the natives of Para make bottles, boots, and other articles of the caout-chouc which distils from it. It is the same as that mentioned by M. de la Condamine in the Memoirs of the Academy of Sciences for 1736, which grows also in the province of Esmeralda, in Peru, which the Maina Indians call *caout-chouc*, and of which they make bottles by means of earthen moulds; they use it also for torches to give them light.

4th, The *artocarpus integrifolia* of South America, a tree which approaches near to the mulberry and fig-tree.

5th, The *ficus religiosa.*

6th, The *ficus Indica.*

7th, The *hippomane biglandulosa* (manchineal tree).

8th, The *cecropia peltata:* the two last among the euphorbia produce also a milky juice analogous to the caout-chouc.

* See Philosophical Magazine, vol. vi.

XLI. *A general View of the Coal Mines worked in France, of their different Products, and the Means of circulating them.* By C. LEFEBVRE, *Member of the Council of Mines, of the Philomatic Society, &c. &c.*

[Continued from p. 164.]

Department of La Côte d'Or.

SOME indications of coal have been announced here, and particularly in the communes of Arefne, Turcey, Montbard, and Chevauney. They deferve to be examined; and Champeaux, engineer of mines, now employed in that diftrict, will no doubt give fome accurate information on the fubject: but hitherto no coal mines have been worked in this department; it can receive its coals from Blanzi by the canal of Charollois, and by going up the Saône as far as Saint-Jean-de-Lône, where the canal of Burgundy begins.

Department of the Côtes-du-Nord.

No coals have yet been found in this department. Indications of coal have been announced near Lannion and Quimper-Gaezence, in the neighbourhood of Pontrieux; but no attention has been paid to them. It is fupplied therefore only by means of its fea-ports, which may receive the coal brought from the mines of Litry, in the Calvados, and thofe which abound in the northern departments, which may be conveyed by land to the canals which terminate at the fea.

Department of La Creufe.

Several coal mines (14) are worked in this country, which is ftill little known in a mineralogical point of view, and which appears worthy of being carefully examined. The communes where coal mines in a ftate of working are found, are thofe of Couchezotte, Bofmoraud, Vavory, St. Palais, and Fautmazuras.

Though their production, according to the information obtained by the Council of Mines, is eftimated in general at 126,000 myriagrammes, it certainly exceeds that quantity, becaufe feveral of the mines have not yet been worked with proper activity. The mean price of the coals at the pit is 10 cents per myriagramme.

Thefe mines are not much worked, becaufe there are very few means of confumption.

If the Creufe, which is faid to be navigable as far as Gueret, could be rendered navigable for boats to Ahun, it would

would open a very useful circulation for the coals of the mines in the neighbourhood of that commune, and would facilitate the transportation of them as far as the Vienne, to which it joins in the department of Indre-et-Loire. These mines, then, would supply in part the consumption of the department of Indre.

On the other hand, if it were possible to render the Thirion, which passes Bourganeuf, navigable from that town to its junction with the Vienne above Limoges, and to ensure the navigation of the Vienne from Limoges to Châtelleraux, where it begins to bear boats, an extensive consumption would be opened for the coals which are on the north and south of Bourganeuf, and make this fuel circulate in the departments of La Haute-Vienne and of La Vienne. This circulation would be exceedingly useful, and increase manufactories and industry.

Department of La Dyle.

This department possesses no coal mines; but it borders on that of Jemappes, the numerous mines of which supply more coals than it has occasion for. It is of importance, therefore, that this fuel, the use of which is general in that country, may be obtained at a price suited to the different places where it is consumed; and that the roads be repaired and carefully maintained in a proper state. Without this attention, the dearness of carriage would throw the inhabitants of La Dyle into a deplorable state of distress in regard to fuel, and produce a hurtful stagnation in the mines of the department of Jemappes.

Department of La Dordogne.

The cantons of Cransac and Terasson (15) afford collections and strata of coals of a good quality and exceedingly rich. These mines would be an object worthy being worked with activity, if the navigation of the Vesere were rendered more certain, and easier.

At present they are worked only at the surface by some proprietors of land, and supply only the local consumption. The product of these coal mines is not known; but it is certain that the working of them would be easy, and that they are capable of affording great resources for a long time.

Department of Doubs.

Several indications of coals have been announced in this department (16). Researches even have been made in different parts, but hitherto no coals have been dug up.

According

According to the general meafures which have been taken by the government, this department is one of thofe where an engineer of mines will be employed; and we have reafon to hope that refearches will be made, and followed with fuccefs.

A very confiderable mafs of foffil bituminous wood has been difcovered at Grand-Denis, in the neighbourhood of Ornans, in the commune of Flanchebouche. This fubftance has not entirely the fame qualities as coals; but in the ftate in which it is found at Grand-Denis it may be advantageoufly employed for feveral purpofes, and particularly under boilers. The managers of the falt-works, who have caufed trials to be made with it, are going to employ it for evaporating the water of the falt-work of Montmorot. This will produce a great faving in the wood employed in that manufactory.

Department of La Drôme.

The difcovery of coal mines in this department (17) has often been announced; but, according to the reports of the engineers of mines who have vifited them, it appears that thefe indications were nothing elfe than bituminous foffil wood, which is frequently found in ftrata of fand, and particularly in the environs of Creft in the diftrict of that name, and in the territory of feveral communes in the environs of Nions.

This foffil wood has been dug up, and particularly at Creft; and though it cannot be applied to the fame purpofes as coals, it is ftill ufeful in thefe countries in the manufactories for fpinning filk.

The department of La Drôme may receive abundance of coals, at leaft for fupplying the communes which lie near to the banks of the Rhone, as thofe of the departments of Ardeche and La Loire can be conveyed to them on that river.

Department of the Scheldt.

The mines of the departments of the North and of Jemappes furnifh abundance of coals to the inhabitants of this department, in which no coal mines are worked.

Department of Eure.

In this department no coal mines are known. It cannot procure this fuel but by going down the Seine to its mouth, or unlefs fome arrive by fea at Honfleur. This port may be fupplied from the coal mines of Litry, in Calvados, or from thofe of the departments of the North.

Department

Department of Eure-et-Loire.

As this department, like the preceding, has no mines in a ſtate of being worked, it can procure no coals but thoſe conveyed down the Loire as far as Orleans, which ſupply its ſouthern part, and thoſe circulated on the Seine, which ſupply the northern. But the land carriage there muſt render this fuel very dear.

Department of Finiſterre.

There are no coal mines in this department (18) which can be conſidered in a ſtate of productive working: however, in conſequence of old indications, ſome reſearches have been within theſe few years reſumed in the neighbourhood of Quimper.

Theſe reſearches have afforded ſome hopes. Small veins of coal have even been found; and as a mine of this kind would be of great importance to the port of Breſt and the other ſea ports and arſenals of this department, the miniſter of the marine has cauſed theſe reſearches to be continued near Quimper with great activity, according to plans approved by the Council of Mines.

Several other indications have been announced at Cleden and at the bottom of the Bay of Dinan. C. Berth had given in the year 6 ſome information in regard to this diſtrict; in conſequence of which he was allowed to continue the reſearches he had begun, and to put himſelf in a condition to obtain a grant when his diſcovery ſhould be fully eſtabliſhed. C. Berth ſet out for Egypt, and it does not appear that attention has ſince been paid to his labours: a coal mine in this point would be of the more importance, as it would be within reach of the harbour of Breſt.

Department of Forêts.

No coal mines are worked in this department, which may receive in the ſouthern part the product of the abundant mines in the environs of Saarbruck, and the coals which may be conveyed on the Moſelle.

Department of Gard.

This is one of the departments of the ſouth of France (19) where this kind of fuel is moſt abundant. On the north of Alais the mines of Cendras, of Portes, of the Foreſt of Abilon, La Grand-Combe, and Pradel, furniſh about 2,200,000 myriagrammes of coals per annum.

The

The coal mines of Bancs, Robillac, Meranes, Saint-Jean-de-Valerifque, furnifh at leaft 900,000 myriagrammes.

Several ftrata of coal are ftill worked in the environs of Pont-Saint-Efprit, and towards Laudun; but it is inferior in quality to the before-mentioned. This is the more unfortunate, as the fituation of thefe mines on the banks of the Rhone would render them of great importance on account of the facility with which they could be tranfported.

If the coal mines in the environs of Alais poffeffed the fame advantages in regard to tranfportation, the quantity dug up might be increafed to ten times the prefent quantity, without any fear of the mines being exhaufted in many years. But they cannot be exported from the country, in confequence of the dearnefs of carriage.

The mean price of the large coals at thefe mines is 7 cents per myriagramme, and that of the fmall coals from 4 to 5 cents.

It appears that a canal is now conftructing from Nimes to Saint-Gilles. The mineral riches and abundant refources in fuel, which the mines in the neighbourhood of Alais would furnifh for ages, are of fo much importance, that a communication ought to be opened with that country by means of a counter-canal to fupply the place of the bed of the Gardon, which is not navigable.

In this department there are alfo fome ftrata of coal worked in the environs of the commune of Vigan. At prefent the working is not carried on with much activity; fome of the pits have even been abandoned in confequence of law-fuits, which are on the point of being decided.

The common amount of the product of this canton may be eftimated at leaft at 200,000 myriagrammes.

Thefe mines cannot find much confumption except by the Herault; but this river is not navigable in the neighbourhood of Vigan.

Department of La Haute-Garonne.

In this department there are no coal mines worked. Some foundings have been made in the environs of Touloufe, in confequence of fome fuppofed indications. Thefe foundings have not confirmed the hopes which had been conceived.

Foffil wood in the ftate of very fine jet has been found in the Foreft of Montbrun towards Montefquieu and Rieux. Specimens of it may be feen in the collection of the Council of Mines.

The department of La Haute-Garonne may be fupplied with

with coals in the eastern part by the mines of Carmeaux, in the department of Tarn. The products of these mines are embarked on the Tarn, and enter with that river into the northern part of the department of La Haute-Garonne. But the difficulties which occur in the navigation of the Tarn greatly increase the price of the coals of Carmeaux. This inconvenience might be removed without much expense. We must therefore hope that measures will be pursued to remove these obstacles, which are equally prejudicial to industry, to commerce, and to all the consumers of these departments. The coals destined for Toulouse and the southern part of the department are deposited at Port Saint-Sulpice, from which they are transported by land carriage.

Department of Gers.

This department, in which no coal mines are known, can obtain this fuel only by land carriage from the entrepôts of Toulouse, or from some of the ports of La Garonne in its northern part.

Department of La Gironde.

Collections of bituminous fossil wood deposited in strata of sand have been discovered in several places in the neighbourhood of Bourdeaux. As this fossil wood seems to be dispersed in great abundance, it would be of advantage to pursue the researches which have been made, with more constancy than has hitherto been the case.

These researches might not conduct to the discovery of a coal mine; but the fossil wood might be used with great advantage as fuel in different operations for which wood is employed.

There are no coal mines worked in this department, but it receives by the Garonne the coals of Carmeaux. This fuel might also be procured with more ease from the abundant coal mines which are known between Terasson and Bergerac, on the banks of the Vesere and the Dordogne, if the navigation of these rivers were rendered easier.

This department might receive also by the mouth of the Gironde the products of the rich mines of the departments of the North. An exchange of the coals, iron works, and of a variety of other articles manufactured in these departments, for the wines and brandy of the Bordelais, which are in request in the whole North, might be made by the French naval trade as well as the English. It is even probable that we should obtain great advantages for the ironmongery trade in India, in consequence of the low price at which the manufactories

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nufactories of the north of France could furniſh theſe articles, of which Bourdeaux would be the entrepôt either for America or for the Eaſt Indies.

Department of Herault.

Coal mines are frequently met with in this department (20). The canton of Bedarieux affords ſome immenſely rich, ſuch as thoſe of Saint-Gervais, of Camplong, of Bouſſaque, and Graiſſeſſac; towards the ſouth, in the canton of Roujan, thoſe of Bouſquet, in the commune of Neffies; towards the ſouth-weſt, in the canton of Saint-Chiniau, the mines of Ceſſenon; and towards the ſouth, near the canal of the two ſeas, thoſe of Azillanet. Some have been found alſo in different places in the environs of Montpellier. A leaſe is about to be granted for working thoſe of Saint-Gely-du-Feſq.

Though the greater part of the coals procured from theſe mines is not of the beſt quality, they are a great relief, in conſequence of the dearneſs of wood, and of the numerous manufactories in which they are employed.

But in general, the means of circulation in the interior of this department are neither numerous nor eaſy. The coals of the mines in the neighbourhood of Bedarieux, which might furniſh a great many, cannot conveniently be tranſported. Some individuals are ſoliciting for grants ſubject to the condition of making a road, which would ſoon give more importance to theſe mines by facilitating the carriage of them to Bedarieux. It would be neceſſary alſo to have a communication with the canal of the two ſeas, leſs expenſive than that by land. It appears that the river Ourbe might eaſily be rendered navigable from Bedarieux to Bezieres. It would then anſwer very well the propoſed object.

The price of coals at theſe mines is 15 cents per myriagramme. But this price is doubled when they have been tranſported as far as the canal.

The coal mines which are neareſt, ſuch as thoſe of Azillanet, are attended with ſome advantages in this reſpect.

The whole product of the different mines of this department may be eſtimated at 1,800,000 myriagrammes.

In conſequence of the ſuperior quality of the coals of Carmeaux, in the department of Tarn, they are received by the conſumers along the canal, in preference to thoſe already mentioned, though the price is nearly double.

Department of Jemappes.

A very large portion of this department (21), and parti-

cularly its southern part, may be considered as an immense mass of coals, in some places scarcely covered by strata more modern than the depôts of that mineral.

The geologue, in traversing the interior of these mines, is astonished at the varied phænomena exhibited by the numerous and successive strata of coals, the inflection, curvatures, or turns of which, in an inverse direction and parallelism, open a vast but difficult field for conjectures respecting their formation, and the revolutions of the globe which must have produced these results: but to enter here into a consideration of these wonderful effects, a description of which must be reserved for particular treatises on the operations of nature, would lead me too far from my present object.

I shall therefore content myself with giving some idea of the resources which this country furnishes, not only to its inhabitants, but to those of several other departments; by which it will be seen how much its productions in coal might be increased, and that they would be sufficient to supply for many years all those parts of France which receive coals by sea from foreign countries.

More than 3000 pits are worked in the environs of Jemappes, Mons, and Charleroi. They are far from being carried to their maximum of activity. The sum of their products, however, amounts, at the least, to 220,000,000 myriagrammes annually; and this product might easily be doubled, if the consumption increased in the same proportion.

In regard to the quality of these coals, it is exceedingly various: these numerous mines furnish coals of every kind, and the price at the pits differs according to the quality from 5 to 9 cents per myriagramme.

The places where they are consumed are, the departments of the Sambre and Meuse, La Dyle, the Scheldt, the Deux-Nethes, and Batavia, in competition with the English coals.

The means of circulation are the river Haine, the Scheldt, the canals which communicate with these rivers, the Sambre and the Meuse, and the large roads from Mons and Charleroi to Brussels.

It may be readily conceived of how much importance it would be to this department, which employs a great number of hands in working its coals, and also to those countries to which these coals might be transported, if the canals and roads were kept in a state of better repair.

Every degradation of the roads which retards conveyance, or which renders more horses necessary, multiplies expense and increases the price of the coals; which ought to be kept as

as low as poſſible, both on account of their utility in our manufactories, and of the neceſſity of maintaining a competition with the Engliſh coals.

The carriage by the cauſeways from Charleroi and Mons to Bruſſels adds greatly to the price of theſe coals. A canal has been projected for uniting the Sambre towards Thuin with the ſmall river of Senne; which would convey the coals of the mines in the neighbourhood of Charleroi to Bruſſels, and would thus form a communication with the Scheldt and Batavia, ſo as to prevent the neceſſity of land carriage.

This canal, valuable in this point of view, would be of utility alſo to the export trade of theſe countries in regard to the glaſs and nails ſent to Holland and to our own ports, and which are thence conveyed to the Indies.

It would be of utility alſo to government for tranſporting the timber of the Foreſt of Souane, through which it would paſs.

To point out theſe improvements will, no doubt, be ſufficient to induce government to pay ſerious attention to them; but until new means of circulation be provided, it is of importance that the exiſting roads ſhould be properly repaired.

I ſhall terminate this article by obſerving, that it is the intereſt of France to facilitate its commercial intercourſe with Holland, and particularly that which relates to the importation of our coals into that country: conſequently, inſtead of laying a duty on their exportation to the amount, as is ſaid, of 20 per cent., this branch of commerce ought to be entirely free. It would be good policy alſo to encourage by bounties the exportation of the coals of this department, eſpecially when deſtined for French ports in parts of our territory which cannot receive this fuel from the mines of the interior, and which if not ſupplied by our mines would procure them from foreign countries.

[To be continued.]

XLII. *On a new Kind of Painting with the Serum or watery Part of the Blood.* By F. Carbonel, M.D. *of Barcelona* *.

The advantages and utility of painting have at all times excited the emulation of profeſſors and of artiſts. The progreſs of this art, which imitates nature, has fortunately correſponded to their wiſhes; but its advancement would cer-

* From the *Journal de Phyſique*, Ventoſe, an. 11.

tainly

tainly have been more rapid if artiſts had been ſooner made acquainted with the new chemiſtry. This aſſertion is proved by the preſent diſcovery.

The neceſſity of painting ſurfaces of different kinds, their various ſituations, and the complex circumſtances which attend the application of colours, have given riſe to the different kinds of painting which are known; ſuch as painting in freſco, painting in ſize, oil-painting, painting with milk, painting on porcelain, painting with wax, painting on glaſs, &c.

The journey of the king of Spain to Barcelona, and the preparation of the edifices deſtined for the uſe of their majeſties, afforded me an opportunity of ſolving a new problem in regard to this art. It was neceſſary to diſcover ſome kind of painting of the common colour of ſtone which might be able to reſiſt rain, which ſhould be unalterable in the ſun, eaſy to be applied on wood, and which ſhould dry ſoon and exhale no bad odour; in a word, a painting equally durable with that in ſize, and which ſhould have the property of being able to withſtand the inclemency of the weather. The ſolubility of gelatin in water, the bad ſmell of oil, the weak adheſion of milk of lime to wood, and its ready alteration by heat, made me ſenſible that it would be impoſſible to have recourſe to any of the known vehicles for ſecuring the colouring matters. After ſome examination I found that albumen * was the only ſubſtance which could anſwer the required conditions, on account of its inſolubility in water, and the conſiſtence it acquires by combining with calcareous earths. This ſubſtance, prepared by the vital power in the animal organs, is found almoſt pure in the white of an egg or albumen, and is found in combination in different animal ſubſtances. But the great viſcidity of the white of an egg, the clots which are formed by its combination with lime, and particularly its dearneſs, made me give up all idea of employing it for painting a whole edifice.

I then conceived that the ſerum of blood, the principal part of which conſiſts of albumen, would be attended with all the advantages of white of egg for the propoſed end, without having any of its inconveniences. Chemical analyſis of animal ſubſtances, indeed, ſhows that the ſerum of blood, commonly called the water of the blood, or, improperly, the lymph of the blood, is a kind of animal mucilage compoſed of albuminous or gelatinous ſubſtances in different propor-

* This painting was much wanted for the bridge which joins the *hotel de la Douane* to the palace of the captain-general, as no other kind could be employed for fear of injuring the queen's health.

 tions,

tions, dissolved in an indeterminate quantity of water, constantly united to pure soda, which reduces the albuminous substance to an almost saponaceous state. There is found also in the serum phosphate of soda, of lime, and of ammonia. But these saline substances are not essential to this combination, since they not only may vary in their proportions, but be wanting either in whole or in part; and even unite in the serum to other salts, such as the muriate of potash, the phosphate of magnesia, &c., without the albuminous, alkaline, or gelatinous substance of the serum being changed, or exhibiting different characteristic properties.

This doctrine, received by all the celebrated modern chemists, induced me to think that the albuminous substance of serum, modified by its combination with gelatin and soda, ought to form with calcareous earth a composition which would retain no more of that viscidity and tenacity assumed by the mixture of the white of an egg and lime, than what might be necessary for answering the proposed end.

These reasons, and the low price of this liquid in large cities, soon induced me to try the effects of the serum of blood with pulverized quicklime; and I found, with much satisfaction, that my first trials corresponded in every respect to the hopes I had conceived.

Practice and Application of the new Kind of Painting.

The preparation of this new kind of paint is easy, and requires very little time. Nothing is necessary but to pulverize the lime, and to dilute it in the serum of blood until it forms a liquid of sufficient thickness for painting; which is then to be applied in the usual manner. The colour which this composition acquires is whitish, and more or less shining, according to the purity of the serum and the whiteness of the lime. This earth may be employed either in the state of quick or caustic lime reduced to powder, or well slaked with a small quantity of water to lessen the adhesion of its integrant parts. It must then be reduced to a fine powder, and be sifted through a close sieve. If kept for some days, it is necessary to preserve it in a close tub or earthen vessel, to prevent its combination with the carbonic acid and water of the atmosphere. The serum is separated from the curdled blood by decantation: but care must be taken to shake the matter as little as possible, and to suffer it each time to remain at rest.

In this composition two things only are to be observed: the first is, that serum being a fluid highly susceptible of corruption, it must be employed the same day it is separated; or at

at furtheſt the day following, provided it be kept in a cool place ſheltered from the contact of the air, eſpecially during the ſummer, when it alters much more eaſily.

In caſe of doubt, inſpection of the fluid alone may ſerve to determine its quality; for the ſigns of its fermentation are very evident. This obſervation is applicable alſo to the colouring liquor, but in a leſs degree. It follows from this circumſtance, that the veſſels which have been uſed for containing, preparing, or applying paint made with ſerum ought to be waſhed every day. The ſecond precaution to be taken is, that as the re-action of the ſerum and lime increaſes in the courſe of time, as well as the denſity of the mixture, in order that it may be preſerved in the neceſſary ſtate of fluidity, or to diminiſh or increaſe it according to the nature of the ſubſtances to be painted and the number of ſtrata to be applied, another veſſel filled with ſerum muſt be provided, to give to the colouring liquor the neceſſary fluidity. It thence follows that the mixture muſt be prepared as it is uſed.

Having aſſured myſelf of the ſucceſsful and conſtant effects of this kind of painting, I tried to mix it with different colouring ſubſtances, to render the application of the invention more general.

The well known re-action of animal ſubſtances and of lime on the metallic oxides, and particularly on thoſe in which oxygen is united to the metal with little force, made me ſuſpect an alteration of ſome colours when mixed with this liquid; an alteration naturally produced by the ſeparation of a part of the oxygen from the metallic oxides. On the other hand, the analogy which coloured chalks have with calcareous earth induced me to believe that their combination would be attended with the happieſt reſult. The oxides of lead, copper, and arſenic, indeed, undergo a ſingular alteration in their reſpective colours, when they are united with ſerum and calcareous earth: but this is not the caſe with cobalt green; which on that account appears to me to be very proper for being uſed as a colouring matter in this new kind of painting. Thoſe earths, however, called red, green, black, or yellow, which are of an argillo-calcareous nature, when mixed with theſe ſubſtances, may furniſh different agreeable colours of a durability equal to the blueiſh colour produced merely by the mixture of lime and of ſerum.

I have however remarked, that the durability of this painting is conſiderably altered when there is mixed with it a very large quantity of colouring earth, ſuch as the black earth uſed for painting an iron colour, or the repreſentation of white marble with black ſpots. To remedy this inconvenience, nothing

thing will be neceſſary but to mix a little white of an egg with the ſerum before it is united with the lime or the black earth. I muſt here add, that wood painted in this manner may be poliſhed, and made to acquire a certain degree of luſtre. In this caſe I have obſerved that freſh ſpermaceti may be ſubſtituted with advantage for the tallow or oil in which the rags employed for rubbing wood before it is poliſhed are commonly dipped. This kind of paint may be applied alſo with the ſame ſucceſs to earthen ware, lead, iron, cut ſtone, &c.

The circumſtances which induced me to employ this new kind of painting, obliged me to make an extenſive uſe of it, without allowing me time to carry my operations any further. More than 300 arrobes * of ſerum were conſumed in the courſe of a few days. In this manner we were able to paint not only the paſſage and bridge of the king's palace, but alſo the windows and doors of the ſame edifice, thoſe of the magnificent building of the Exchange, the *Place de Taureau*, and many private houſes. The happy effects it produced, when expoſed to the eyes of the public, are a ſufficient proof that practice here perfectly correſponds with theory.

It is hardly neceſſary to obſerve, that the ſurfaces to be painted muſt be ſmooth; that the wood muſt be covered with a ſtratum of plaſter; and that this painting muſt not be applied over painting with oil or with turpentine, becauſe the heat would make it crack.

I propoſe to continue the ſmall number of trials I have already made, to render the uſe of my diſcovery more general. The following is the reſult of thoſe which I have hitherto been able to attempt.

In conſequence of the viſcidity, adheſion, and ſpeedy deſiccation of this compoſition, it may be employed in the ſame manner as bitumen, to cement with great ſolidity broken articles of every kind. In this caſe it oppoſes a ſtrong reſiſtance to the action of fire, water, many of the gaſes, and to vapour.

As ſerum contains a large quantity of albuminous matter, having myſelf ſeparated from it nearly half its weight, it may be employed with advantage for clarifying ſugar, wine, and other ſubſtances, in a more œconomical manner than by the white of an egg.

This new compoſition may be employed alſo for covering the ſurface of damp walls intended to be painted in oil colours; taking care, however, to cover it with a coating of

* An arrobe weighs 25 or 26 pounds.

plaſter

plaster and glue, to prevent its re-action on the colouring parts of the painting.

The hardness of this substance, and its susceptibility of receiving a polish, induce me to believe that it might be employed on stucco, and for imitating it on walls and ceilings.

It may be used also for uniting water-conduits, and for cementing stones of all dimensions, and especially those which are put into wood caissons for building under water.

It appears from different works, that the antients had conceived the idea of employing blood in the composition of their cements and mortar; but the use of it in painting was before unknown. Besides, there was too great a distance between this use of blood and that of serum freed from the fibrous part and the colouring matter, to admit of any doubt that the principle of my discovery is entirely my own.

It follows from what has been here said, that this new kind of painting may be added to those already known, and that it may be called painting *in serum*; that it is as easily applied as prepared; that the elements of it are common, and of little value; and that it unites in it all the advantages of painting in oil and in distemper, without having any of their inconveniences.

XLIII. *On the Kind of Air-Furnaces employed in Iron Foundries for casting large Pieces of Ordnance, Shafts for Mills, Cylinders, and other heavy Articles.* By Mr. DAVID MUSHET, *of the Calder Iron Works**.

THE furnaces about to be described are employed for melting pig-iron with the flame of pit-coal. Furnaces of this kind are constructed of various sizes according to circumstances. The small sizes will run down from seven to ten hundred weight, and are used in small foundries for what the trade call *jobbing*.

Fig. 1. (Plate IV.) a ground plan of two large air-furnaces, and chimney for melting pig- or cast-iron with the flame of pit-coal.

The letters A B C D point out the exterior dimensions of the stalk or chimney, which is first erected, leaving two openings or arches into which the fore-part of the furnaces are afterwards built. The breadth of the chimney at the particular place which the plan exhibits is 16 feet from A to B, and from A to D or from B to C 6 feet 6 inches. The plan is drawn at that elevation where the flame enters the chimney

* Communicated by the Author.

by the flue or throat, narrowed on purpofe to throw back part of the flame, and keep the furnace equally hot throughout, as may be more particularly viewed in the vertical fection, fig. 2.

EE, the furnace bars on which the coals reft, and where the combuftion is maintained.

F F, openings called teafing-holes, by which the coals are introduced to repair the fire.

G G, fire-brick buildings called bridges. Thefe are meant to concentrate the flame, that it may act as violently on the metal as poffible. Upon the height of the bridge much depends in fufing the metal fpeedily, and with little lofs. The height of this may be feen in the vertical fection, fig. 2. G.

H H, the charging doors, by which the metal is introduced in the fhape and ftate of pig-iron, lumps, fcraps, &c. &c. The iron generally occupies the furnace acrofs to I, called the back wall, and is never meant to approach the bridge nearer than the dotted line, left the metal in melting fhould run back into the grates, in place of defcending into the general refervoir or cavity below. The corners or notches, *b*, *b*, *b*, *b*, receive a ftout caft-iron frame lined with fire-bricks. This is hung by means of a chain and pulley, and can be raifed and depreffed at pleafure. This frame is, properly fpeaking, the charging door, and is always carefully made air-tight by means of moiftened fand.

KK, the flues or openings by which the flame enters the chimney. Thefe are 15 inches by 10. On maintaining thefe openings of a proportionate fize to the other parts depend in a great meafure the powers and œconomy of the furnace.

L L, lading doors, by which ladles are introduced, in the cafe of fmall furnaces, to lift out the metal and diftribute it to the various moulds.

M M M M, binding bolts to limit within proper bounds the expanfion which takes place in the building when the furnace is highly heated.

Fig. 2. vertical fection of one of the furnaces, and its appropriate ftalk or chimney.

E, the grates.

F, the teafing-hole.

G, the bridge.

H, the charging door.

K, the flue or opening into the chimney.

L, the lading door.

M M, the binder or binding bolt.

N, the interior of the ftalk or chimney, 30 inches fquare.

OO, the fire brick-work, 9 inches thick.

PP, fpace

PP, space of 2 inches for stuffing with sand.

QQ, common brick building.

RR, cast-iron lintels, over which are thrown double 9-inch arches, so that at any time the inferior building can be taken down to make repairs, without shaking or in the least injuring the chimney.

S. The dotted lines here are meant to represent what is called the tapping-hole. When a large piece of goods is to be cast, lifting the metal with ladles would be impracticable. A sharp-pointed bar is driven up this opening. The iron then flows freely out into a large bason of sand made for its reception. It is then conducted, by collateral channels, into the mould.

The space under the curved dotted line from G to L, by S, is filled with a mixture of sand and ashes. When the furnace is prepared to melt, the whole of the bottom receives a stratum of sharp clean sand about two inches thick. This is broken up at night, and fresh sand is substituted for it before the fire is kindled in the morning.

Fig. 3. is a horizontal section of the chimney or stalk, taken where the flues assume a perpendicular direction. The letters in this figure correspond to those in the vertical section, fig. 2. The height of the chimney ought not to be less than 45 feet: if 50 feet, the effect will be sooner and of course better produced.

Remarks upon the Melting of Iron in these Furnaces.

The effect wished to be produced in air-furnaces is the fusion of a certain portion of pig- or cast-iron for the purpose of being poured or run into moulds to form articles of almost every description.

The preparation previous to melting is as follows:—After the bottom of the furnace is laid, and smoothed with fresh sand, and all the openings made air-tight, the furnace-man introduces a kindling at the teasing-hole, accompanied with new pit-coal. In a few minutes a considerable volume of dark flame mixed with smoke is produced. The fire quickly gathers strength; more coal is introduced; and the furnace now becomes filled with a yellow-coloured flame. By continuing this operation for an hour, or an hour and a quarter, the furnace and flame will have become completely white; the latter steady, and at times apparently without motion. The furnace-man now judges the bottom to have been sufficiently hardened for receiving the pig-iron without any risk of sinking. The charging-door is now opened, and the pig-metal thrown carefully and regularly upon that part of the

bottom formerly defcribed as being appropriated for its reception. The door is again clofed and made air-tight, and the operation of firing continued with unremitting care and attention.

The time of melting depends entirely upon the quantity of metal introduced. The furnaces defcribed above are capable of melting from 50 to 60 hundred weight of metal each, and when there is a moderate circulation of air they will perform this work in $2\frac{1}{2}$ or 3 hours. In half an hour after the metal is introduced it affumes a blackifh red colour. It then begins to brighten with every additional fire, and in about one hour appears white, and begins to lofe fhape, and refemble a wreath of fnow.

An eye accuftomed to fuch heats will now difcern the metal beginning to drop, and run down the inclined plane in very beautiful ftreamlets refembling quickfilver. Eight or ten of thefe are vifible at a time, and after proceeding half way down begin to form junctions with each other, and flow connected into the general cavity or refervoir. By-and-by this becomes filled, and literally forms a beautiful molten mirror, in which fometimes part of the interior furnace is reflected.

The furnace-man, by fearching at the bridge with his fire-iron or teafer, judges when the metal is nearly all gone. Of this he is certain by looking up from the peep-hole of the lading-door. If the ftreamlets of the running metal have ceafed, then the whole is melted, and ready for running out.

In the operation of melting, the three following circumftances ought to be particularly attended to: the thinnefs or hotnefs of the metal; the wafte or lofs fuftained in melting; and the quantity of coals employed.

The firft is of the utmoft importance, as many articles in the foundry bufinefs require the metal in a ftate of the greateft divifion; otherwife they will be found imperfect when taken from the fand, and unfit for fale. The furnace-man, therefore, is always on the watch to replace the fire as it decays, and keep a large and fharp volume of flame conftantly paffing over the metal.

The wafte or lofs of real metal is alfo an object of great importance. This always bears a relation to the quality of the iron, the ftrength and cleannefs of the coals, and the judgment and attention of the melter. Strong iron is found always more difficult to fufe; this neceffarily expofes it for a long period in contact with the flame. The reverfe happens with metal that is more fragile, and eafier broken in the pig. The length of the expofure in fufing depends on this; and other

other circumstances being alike, the loss or waste of metal will also be in the same ratio.

There are, however, other facts not unworthy of notice. No. I. pig-iron, or richly carbonated metal, when run from an air-furnace, will be found in point of quality little better than No. II. or carbonated iron. This is owing to a quantity of its carbon being destroyed during the fusion. The loss in melting No. I. iron, therefore, chiefly consists of carbon; and the deficiency of metal ought never, with a clean bottom, to exceed 1 cwt. in 20.

Carbonated or No. II. iron also becomes deprived of a considerable portion of its carbonaceous mixture in fusion; and when run from the air-furnace is seldom better than No. III. metal. The loss sustained in melting may be averaged at $7\frac{1}{2}$ per cent.

No. III. pig-iron is, after melting in an air-furnace, found whitish or mottled. It is seldom susceptible of the same nice degree of division as the superior qualities, and loses in fusion a much larger proportion of metal, seldom under 10 per cent. and frequently $12\frac{1}{2}$ or 15.

The quantity of coals requisite to melt a given quantity of iron is various, as much depends upon the quality and fusibility of the metal. If the furnace goes one heat a day with No. I. or II. iron, the quantity of coals will be from 20 to 25 cwt. for a ton of iron. If two or three heats a day, or as many tons of iron are melted at one kindling, the proportion of coals will be nearly weight for weight of the iron melted when the coals are mixed with a fair proportion of small: with strong large splint coals, one ton of good pig-iron may be completely reduced with from 12 to 15 cwt. including the previous heating of the furnace.

XLIV. *Observations on the Freezing of Water and the Nature of Snow: in a Letter from Professor* DRIESSEN *to Dr.* VAN MARUM*.

AS the present season has afforded us an opportunity to make experiments on the freezing of water and the nature of snow, I flatter myself that it will give you some satisfaction to be made acquainted with the results I have obtained in regard to this important subject; and I give you full liberty to publish them, if you think they are likely to be of any utility.

* From *Algemeene Konst en Letter-Bode*, No. 14, 1803.

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At present, however, I shall give you only a short account of my experiments, because I hope, in the course of a few years, to collect materials for a more elaborate work on the freezing of water, and the state of the atmosphere in winter; having been induced to turn my attention to the latter object by the observations I had made, and which I mentioned to you three years ago, on the force with which a considerable quantity of vapour, especially during the time of strong frost, is disengaged in an aëriform state from freezing water, and rises, as it were, with violence into the atmosphere; and on the increase of volume which the air thereby acquires even in close vessels, and which it retains during the strongest cold.

When I traverse the snow-clad fields during the coldest days of winter; when I consider the dry state of the air, and of every thing around me, arising, no doubt, from a strong and continued tendency of the aqueous particles, of which I neither see nor feel any thing, to rise into the higher regions of the atmosphere; and when in consequence of the serenity of the heavens I can distinguish very small objects at a great distance, I cannot help admiring the power of nature, as yet so little known, by which air so cold and so much condensed can be so intimately connected with water. This water, in my opinion, can be considered only as in an aëriform state, as such combined with the atmosphere by a very strong affinity, and forming with it one and the same body: I must observe also, that this affinity seems to increase in the ratio of the cold.

The atmosphere being an elastic fluid in which caloric is combined by the strongest affinity with its bases, it by these means appears to be more capable of preserving by the power of this union, in the state of atmospheric vapour, the aëriform water which has so weak an affinity for its specific caloric. The air thus condensed, and containing more aërial particles in the same space than in summer, attracts, on this account, the water with much greater force. The water becoming aëriform during the process of freezing, and in that state entering into combination with the air, has no need of external heat to maintain it in that state of union. The aëriform state of water, which in summer is maintained by the heat of the surrounding bodies, is in this season preserved by a state of greater affinity.

Is the water then, during this cold, serene, wintery atmosphere, in a more perfect state of union with the air? I answer in the affirmative; and therefore I can readily conceive why the mercury stands at such heights in the barometer during that season. This air also may be considered as a receptacle

ceptacle for a very large quantity of combined caloric, which by the decompofition of the atmofphere returns again, in a great meafure, with the water, as fenfible heat to the furface of the earth: in the phænomena of combuftion, refpiration, and other great operations in the œconomy of nature, I can fee not only a decompofition of vital air, but that alfo of aëriform water, which is fo intimately connected with air. But as I dare not venture to proceed further in this path, for which I yet feel myfelf too weak, I fhall return to the principal object of this paper.

I have repeated the experiments which I before communicated to you, as already obferved, and with the fame refult: I entertained no doubt that the dilatation of freezing water, previoufly deprived of air, is to be afcribed, befides to cryftallization, in particular to the aëriform water, which during the freezing being carried off with the liberated caloric, deranges in its paffage and feparates the cryftals from each other. I had entirely given up the idea of the exiftence of air in chemical union with water, or with its bafes, which could not be feparated by boiling, and which by freezing might again be liberated in an elaftic ftate, till the treatife of my friend Dr. Uilkens, written in March 1800, came into my hands.

The well-known merit of this philofopher, the modefty with which he communicates his ideas to the public, made me confider it as my duty to examine his objections with all due refpect; but at the fame time to prove to my pupils, if poffible, the truth of my experiments.

According to my experiments, water can be perfectly freed from air. In fuch water no air-bubbles arife during the procefs of freezing, provided the air has no accefs to it. Its communication with the air would inftantly make them appear.

For the fake of thofe who may be defirous to repeat my experiments, I fhall defcribe an infallible method by which the fmalleft traces of air in water may be detected. None of the means commonly ufed for the purpofe are fufficient when accuracy is required, as is the cafe in the prefent inftance.

I pour the water deftined for examination into an earthen veffel, communicate a blue tint to it by a fufficient quantity of folution of litmus, which I preferve ready, of a certain ftrength, for fuch purpofes: I then fill with it a flafk in fuch a manner, that the aperture of the flafk is kept under water during the time of filling; taking care to fhake the flafk, that the fmalleft air-bubble may not remain in it. I then invert the flafk in the water, and introduce into it, in the common manner,

manner, pure nitrous gas until 1-16th or 1-20th of it is filled. I then place the flafk in a difh, and intercept its communication with the atmofphere by means of mercury. Now, if there be any air in the water, its oxygen gas muft unite with the nitrous gas, producing more or lefs acid according to the quantity of the oxygen gas. The folution of litmus, therefore, muft acquire a red colour, and that, *cæteris paribus*, more or lefs, and in a fhorter or longer time, according to the quantity of oxygen prefent in the water. When you intend to examine different kinds of water at the fame time, after it has ftood two days introduce into it carefully, in fmall quantities, by means of a fyringe, an alkaline folution; and from the quantity of the folution neceffary to reftore the blue colour to the folution of litmus, which has been turned red, you can eftimate very accurately the *relative* quantity of oxygen gas, and confequently that of the common air mixed with the water.

A proof of this kind was neceffary in order to determine with certainty whether water could be entirely freed from oxygen gas, and confequently from common air; for azotic gas is never prefent in water alone.

Diftilled water, however carefully prepared, and immediately received as it comes off in flafks clofely ftopped, cannot bear the proof by nitrous gas. Water freed from air by means of the air-pump again imbibes it as foon as the air has free accefs to it: even if the water be boiled in the flafk, when expofed for a few moments to the atmofphere it becomes, in fome meafure, reddifh by this proof.

After a great many fruitlefs attempts, I was never able to free water entirely from air but by the following procefs:

I boil pure water for at leaft two hours in a large bafon; colour it with litmus; warm a large ftoppered flafk in it, and, holding it by means of a pair of forceps, fill it entirely with the boiling water. I let the flafk remain for at leaft half an hour with its aperture fome inches below the furface of the boiling water, frequently ftriking its fides with the forceps to expel any air which may ftill remain in it. I then invert the flafk, place it in an earthen veffel, and immediately introduce nitrous gas: I then intercept all communication with the external air by mercury, of which there muft be a fufficient quantity, on account of the diminution of the volume of the water, and particularly of the nitrous gas, by cooling; in confequence of which the mercury rifes into the flafk to a certain height. In this manner, I had the fatisfaction to fee that the liquor retains its blue colour for weeks; a certain proof that water can be entirely freed from air.

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I was now enabled to proceed a ſtep further, and to determine whether after this proceſs any of the *baſes* of air, and, in particular, free oxygen, remained in the water, which during freezing might be extricated in the ſtate of elaſtic air.

On one of the coldeſt evenings of the month of December 1801, I filled ſome flaſks, in the manner already mentioned, with blue-coloured water freed from its air and with nitrous gas, and others with water without any addition; all of which I placed in the window. Next morning no change was to be obſerved, though the froſt had been very ſtrong: the water in all the flaſks was in a ſtate of perfect fluidity. This phænomenon, I acknowledge, is very common: but I mention it becauſe ſome conſider the impeded diſengagement of air as the cauſe of it; an idea which I was not ignorant of, and which agrees with the reſult of this experiment.

This circumſtance rendered the experiment more agreeable; and being certain that every thing would freeze on the leaſt agitation, I was enabled to obſerve better the ſmalleſt change which would take place during the proceſs of freezing.

What I expected took place; none of thoſe preſent during the freezing could obſerve the leaſt change of colour. We every where ſaw bubbles appear, and diſperſe themſelves widely through the lump of ice; but they were merely nitrous gas. At the end of two days we did not perceive the leaſt trace of redneſs in the ice, till the flaſk at length burſting, and the air thus having free acceſs, the whole maſs inſtantly became red. The flaſks which contained no nitrous gas, or tincture of litmus, exhibited during the freezing of the water no air-bubbles; but when the flaſks burſt in conſequence of the froſt increaſing, the maſs of ice was immediately interſperſed here and there with air-bubbles.

But though theſe experiments fully proved my idea in regard to the origin of air-bubbles in ice, I was very deſirous to obſerve the phænomena of freezing *in vacuo.*

My former pupil and worthy friend Van In En Kniphuiſen, lord of Nienoord, who has added ſo much luſtre to his noble birth by an aſſiduous cultivation of the ſciences, was ſo kind as to aſſiſt me in theſe experiments, and to allow me the uſe of his valuable apparatus.

The experiment of Lichtenberg falls to the ground. We have ſeen curious phænomena. I ſhall give you an account of them, which I find in my memorandums, dated January 16, 1802. This will be more than ſufficient to induce all the amateurs of the ſtudy of nature to repeat my experiments.

We had already obſerved ſeveral times, with great ſatisfaction,

tion, the ſpongy appearance which water acquires by freezing *in vacuo*, in conſequence of its greater expanſion, which every time that the glaſs burſt was unaccompanied with the appearance of air-bubbles, but immediately on the introduction of air they ſpread themſelves through the whole maſs. Hence there was no doubt that this increaſed dilatation was entirely the conſequence of the aëriform water, the expanſion of which was not impeded by the preſſure of the atmoſphere. We repeated this experiment for the laſt time on the ſame day, when the froſt was perceptibly leſs intenſe. A beer-glaſs capable of containing eight ounces was two-thirds filled with diſtilled water as much freed from air as poſſible: it was immediately placed under the receiver of an air-pump, and the air was exhauſted as ſpeedily as poſſible. At the end of ſome hours we ſaw a phænomenon which appeared ſo ſtrange and ſingular, that I was at firſt incapable of ſaying what it might be. The freezing water had raiſed itſelf up in a ſtraight column nearly three inches above the glaſs, being in thickneſs in the middle above a line, and at the bottom two lines. The water was equally frozen at the ſurface and throughout the whole maſs: the cellular or ſpongy appearance exiſted only under the column, and extended to the middle of the baſe. No air-bubbles were any where to be ſeen. It is probable that the ſlowneſs of the freezing may have contributed to produce this ſingular phænomenon.

We conjectured, and with great probability, that this column was hollow, and had ſerved for diſcharging the aëriform water. As ſoon as the air was admitted under the receiver we ſaw a movement in the pipe like that of air which penetrates into a wet glaſs tube, and in the mean time a great many air-bubbles appeared in the cavities at the bottom of the column. By introducing a ſtiff briſtle into the aperture, and employing a magnifying glaſs, we could eaſily trace the hollow part of the tube to the cavity where the air-bubbles were.

The air, therefore, on this occaſion had no ſhare in the expanſion of the ice; and as our water before freezing never contains ſo much air, it appears that during the freezing it could contribute little or nothing towards the expanſion.

Expanſion is a phænomenon common during all cryſtallization, and is a conſequence of the peculiar regular form which the moleculæ of bodies adhering mutually to each other aſſume, and by which means larger vacuities are formed. Expanſion is increaſed, and particularly during the cryſtallization of water, by the aëriform ſtate to which a part of it is brought by the diſengaged caloric.

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While a part of this caloric, disengaged during the process of freezing, keeps the water beneath the crust of ice in a state of warmth and fluidity, another part, in consequence of the aëriform expansion of the water, forms the cavities in the ice by which the so necessary communication between the external air and the fluid water is maintained, in order to support the life of those beings which reside in it.

And what would be the case with vegetation if ice were a body impermeable to air? While the warmth of the earth is maintained as far as possible under its hard surface by the power of congelation, the air continually penetrates through it; by which means the principles of germination are preserved in the seeds, and prepared for development.

My experiments have also shown that ice water produced by a slow thaw contains more air than water which has not been frozen during the same time.

But snow water in particular contains much more air than common rain water; and this air contains more oxygen than the air obtained from rain water.

The opinion of Hassenfratz, which may be seen in the fourth part of the *Journal Polytechnique* *, is fully confirmed, whatever Dr. Carradori may assert to the contrary †. Snow water may, with great propriety, be called *oxygenated water*. This I can incontrovertibly prove, not only in the usual manner by sulphate of iron, but in particular by means of nitrous gas; and have shown it more than twenty times in my lectures, as a thing of importance not only to philosophy but also to pharmacy. What I assert may be easily proved in the following manner:

Fill two flasks, one with snow and the other with rain water, and place them, inverted, in boiling water: the air will then evidently be seen to collect itself at the bottom (now the top). Yesterday my amanuensis, H. Uilkens, exhibited to us this important phænomenon. A flask filled with rain water, which at that time consisted chiefly of melted snow, did not present one-half of the air-bubbles exhibited by snow water collected in the garden.

Besides this larger quantity of air, and particularly oxygen gas, snow water contains also much fewer extractive particles than rain water; and from these two circumstances we can explain the properties by which this water distinguishes itself from rain water, as a medicine, as drink, and in many œconomical uses.

It is needless to inquire, why this water is sometimes hurt-

* See Phil. Mag. vol. iii. p. 233. † Ibid. vol. iv. p. 217.

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ful in caſes of inflammation of the eyes? why it occaſions colic, griping pains, and other affections, when drunk cold? But, without enlarging further on this ſubject, I ſhall here mention a remarkable effect of the wiſe diſpenſations of Nature. As ſnow water contains oxygen united with little caloric, it thereby poſſeſſes a ſtronger tendency to communicate its oxygen to bodies ſuſceptible of oxygenation. No ſubſtance in nature deprives water of its oxygen with more avidity than fertile earth. Snow water mixed with vegetable mould, and expoſed to the ſolar light, improves the mould in a ſhort time. Almoſt as ſoon as a lively fiſh placed in a glaſs of water containing oxygen makes the ſuperfluous oxygen diſappear, and fills the water with carbonic acid gas in its room, is the oxygen taken up by the earth aſſiſted by the influence of the light. Pure earths do not exhauſt ſnow water of its oxygen; nor do they attract the oxygen of the atmoſphere, as aſſerted by Von Humboldt.

I have long been convinced of the contrary, from various experiments. It appears, in particular, that carbon is the principle whoſe ſtrong affinity for oxygen produces ſo many important phænomena, and which nature continually employs in the compoſition and decompoſition of organic bodies: it is carbon alſo which in this caſe deprives water of its oxygen, and conſequently frees it from what renders it prejudicial to health, and unfit for the purpoſes of life.

That which is prejudicial to us is improved by the ground, and at the ſame time gives power and activity to the mould.

When the ſnow covers the earth, it tends to keep it warm; the ſnow, as a body which cannot conduct caloric in a very ſmall degree, prevents, by its interpoſition, the cold air from taking the caloric from the earth. But this does not appear to be the only cauſe of its fertilizing power. The ſnow melting and penetrating into the ſoftened earth communicates to it oxygen, promotes by theſe means the germination of ſeeds: the young plant grows with more vigour, becauſe the carbon of the fertile earth combining with the oxygen is converted into carbonic acid, and thereby acquires more ſolubility; while the water, by its ſtimulating property, contributes to excite that activity which had been rendered dormant in the roots by the cold.

This fertilizing power of ſnow, which was before aſcribed to nitrous particles, but the preſence of which was never proved, ſeems thus, according to the idea of Ingenhouſz, Haſſenfratz, and other naturaliſts, to be explained in a more ſatisfactory manner.

I ſhall now conclude this ſhort eſſay by expreſſing a hope

that

that I have here given philosophers a further inducement to admire with me the great and noble operations of the divine providence, which so evidently appear in the different changes effected in air and water, and which are so necessary for supporting and maintaining the creation.

Groningen,
February 26, 1803.

XLV. *Observations on the Lotus of Egypt.* By Alire Raffenau-Delile, *Member of the Institute of Egypt**.

SINCE my return from Egypt I presented to the Museum of Natural History different kinds of seeds and several bulbs of the *nymphæa cærulea*, of which an accurate description was given in Egypt by C. Savigny, my colleague. These bulbs began to germinate towards the end of Messidor, when kept immersed in water. I collected them in the island of Rosetta in the month of Ventose, year 8; and though I had kept them two years without planting them, they had not become desiccated: one of the plants of the nymphæa has already produced several flowers somewhat smaller, less odorous, and of a paler blue colour, than those in Egypt.

Though I made a tour with the Commission of Arts into Upper Egypt during the time of the inundation, which is that also of the increase of the two kinds of nymphæa of the Nile, we met with none of these plants in that country.

The waters of the Nile rise to a considerable height in the Said, and much less in Lower Egypt. The nymphæa, therefore, easily reaches the surface of the water, during the inundation, in the lakes and the canals of the Delta, where they are not hurt by the current of the river. It is, perhaps, for a contrary reason that the nymphæa does not grow in the Said.

We observed the nymphæa cærulea painted and engraven on the Egyptian monuments much oftener than the two kinds of lotus mentioned by the oldest historians. This nymphæa has a great resemblance to these kinds of lotus, and appears to be a third species of it.

Most authors who have undertaken to make known the lotus in regard to its antiquity have fallen into many errors; but Mahudel, of the Academy of Inscriptions and Belles

* From *Annales du Museum National d'Histoire Naturelle*, No. 5.

Lettres *, and lately professor Sprengel, of Halle †, have given very accurate information respecting these plants.

The expedition to Egypt afforded me an opportunity of making the following observations on the same subject: they are naturally connected with those already made in Egypt by C. Savigny on the nymphæa cærulea, and complete the history of that plant.

Herodotus ‡ relates that the Egyptians fed on the lotus which grew in the waters of the Nile. He calls this lotus a lily, and says that the seeds, similar to those of the poppy, were employed for making bread. He adds, that they ate also the roots of the lotus, which were round, of the size of an apple, and of a sweet and agreeable savour. Herodotus then speaks of another kind of lily resembling a rose, which grew also in the Nile, the fruit of which had the form of a wasp's nest, and which contained several seeds good to eat, and of the size of an olive.

Theophrastus § gives a very accurate description of the same plants:—" The lotus," says he, " grows in the fields when they are inundated. Its flowers are white, and have petals like those of the lily. They spring up in great numbers close to each other. They shut their leaves at sun-set, and conceal their fruit. These flowers open again when the sun reappears, and rise above the water; and this alternation is repeated till the fruit is completely formed, and the flowers have dropped off. The fruit is equal to that of a large poppy, and contains a great number of seeds similar to grains of millet. The Egyptians deposit the fruit in heaps, and suffer the rind to putrefy; they then separate the seeds by washing them in the Nile, dry them, and knead them into bread. The root of the lotus called *corsion* is round, and of the size of a quince. Its rind is black, and like that of the chestnut. This root is white in the inside, and is eaten either raw or boiled."

The lily of the Nile, like the roses mentioned by Herodotus, is called by Athenæus || Egyptian bean, and the rose lotus. Theophrastus gives it the name of *bean*.

" This bean grows in the marshes and ponds. Its stem is four cubits in length, and as thick as the finger. It resembles a reed without knots. The fruit it bears is shaped like a wasp's nest, and contains about thirty beans a little prominent, each deposited in a different cell. The flower is twice as large as that of the poppy, and entirely a rose. The leaves are sup-

* Histoire de l'Academie des Inscriptions, vol. ii. p. 285.
† An iquitatum botanicarum Specimen primum, p. 47.
‡ In Euterpe, cap. xcii.
§ Theophrasti Hist. Plant. lib. iv. cap. 10.
|| Athenæi Deipnosoph. lib. iii. p. 72; lib. xv. p. 677.

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ported by pedicles similar to those of fruits: they are large, and have a resemblance to a Thessalian cap. When one of the beans is bruised there is seen in the inside of it a small body folded together, from which the leaf arises. The root is thicker than that of a strong reed, and has partitions like the stem. It serves as nourishment to those who reside near the marshes. This plant grows spontaneously, and in abundance. It is sown also in the mud, by forming for it a bed of straw, in order that it may not rot."

The lotus of Herodotus and Theophrastus grows also in Egypt. It is the *nymphæa lotus* of Linnæus *, the characters of which, compared by C. Savigny to those of the *nymphæa cærulea*, agree with the descriptions given by the antients.

In regard to the rose lily or Egyptian bean, which is frequently carved out among the ornaments and symbolical representations of the Egyptian temples, it no longer grows in that country; and would have remained unknown to naturalists had it not been discovered in India. This plant has been called by Linnæus † the *nymphæa nelumbo*. Its fruit, which the Greeks compare to a wasp's nest, has a perfect resemblance to it. They called it *ciborion* ‡ on account, no doubt, of its resemblance to a cup. This fruit is shaped like the spout of a watering-pot, and is flatted at the upper part, which contains from fifteen to thirty small fossæ, containing a like number of seeds of the size of a nut, and somewhat prominent. The plumula §, which is the rudiment of the leaves, is, indeed, rolled up in the middle of the seed, as Theophrastus says. The flowers are roses, and very large. The leaves are orbicular, thuriform, and about two feet in diameter ||.

Belon has confounded the Egyptian bean with the colocasia ¶ (*arum colocasia* Linn.), which is cultivated in Egypt: as the Greeks often gave the name of *colocasia* to the root of the Egyptian bean **, it was a difficult matter to avoid confounding these two plants.

Sprengel remarks, that the appellation of *colocasia* was given also to the *nymphæa lotus* ††.

But we receive as much information respecting these plants

* Species Plantarum, p. 729.

† Ibid. p. 730.

‡ Athenæi Deipnosoph. lib. iii. p. 72; & lib. xi. p. 477. Diodorus Siculus, lib. i. Dioscorides, lib. ii. cap. 97.

§ Gærtner De Fructibus, &c. tom. i. p. 74. tab. 19.

|| Hortus Malabar. tom. xi. p. 61.

¶ Belon, Observations, lib. ii. chap. 28.

** Athenæi Deipnosoph. lib. iii. p. 72 & 73.

†† Antiquitat. botanic. Specimen prim. c. 89.

from antient ſculptures as from the account of hiſtorians. The roſe lotus, or Egyptian bean, is very correctly repreſented in the moſaic of Paleſtrine, an explanation of which has been given by Barthelemy in the Memoirs of the Academy of Inſcriptions and Belles-Lettres *. The fruit, the flowers, and the leaves of that plant are exceedingly like. They float on the ſurface of the water in a lake which carries ſeveral barks during the time of a feſtival. This painting brings to remembrance a paſſage of Strabo †, who ſays, that people made excurſions of pleaſure in boats on the lakes covered with beans, and that they ſheltered themſelves from the ſun with the leaves of that plant. On the Egyptian monuments Harpocrates is repreſented above the flower of the fruit of the roſe lotus. This plant, ſo well known in antient Egypt, is at preſent celebrated in the religion of the Bramins, and is often placed among the attributes of the Indian deities ‡.

It is not poſſible to ſay to what kind of lotus the flowers ſeen repreſented on the heads of the Egyptian kings or deities in ſeveral medals belonged, becauſe the ſpecies of lotus differ chiefly in regard to the colour of their flowers, and the form of their fruits or leaves; but on the walls of the temples of Egypt, and on the caſes containing the mummies, they may be eaſily diſtinguiſhed when the painting is in good preſervation. The Egyptians often repreſented the leaves of the white lotus (*nymphæa lotus*) of the ſame ſize as the flowers, though naturally the leaves are much larger; but they have omitted to mark the indentations of theſe leaves, which indeed are wanting when the plant is very young. I have, however, ſeen in the table of Latopolis this lotus repreſented with the leaves indented.

But it would be in vain to ſeek for ſcrupulous exactneſs in allegorical ſculptures. Thus on the baſe of the ſtatue of the Nile, placed in the gardens of the Tuileries, the fruit of the lotus is very exactly repreſented, but the leaves which accompany it are not thoſe of that plant.

The fruit of the white lotus, which has the ſame form as

* Hiſtoire de l'Acad. des Inſcript. 1790. The *Pitture antiche di Pietro S. Bartholi*, which repreſent the moſaic with its colours, may be ſeen in the library of the Pantheon.

† *Strabo*, lib. xvii. The Greek text has been badly interpreted by tranſlators, who ſuppoſed that the boats rowed along under the ſhade of the leaves, which roſe to a great height above the water. Theſe leaves float on the ſurface of the water, and are very broad. It appears that the boats were covered with them in order to form a ſhade, as they are covered in Egypt at preſent with the leaves of the date-tree and with reeds.

‡ Syſtema Brahmanicum Fr. Paullinii, à Bartholom. tab. 9 & 10.

that of the poppy, may be distinguished on the Egyptian monuments. In my opinion, this resemblance has made the fruit of the lotus, delineated on several Egyptian medals, to be confounded with that of the poppy. The fruits represented on these medals are the same as those sculptured on the Egyptian monuments anterior to those of the Greeks. It does not appear from any historical testimony that the Egyptians ever made much use of the poppy; and they rather placed the fruits of the lotus among the attributes of Isis, with ears of corn, as a sign of abundance and fertility, since they were long accustomed to make a sort of bread with the seeds of that plant. The Egyptian lotus was very little known to the Greeks and the Romans, who compared it to the most common plants. Herodotus calls the lotus a *lily*; Theophrastus compared it to the *poppy*, and Pliny calls its flowers *poppies* *. Another cause which may have occasioned the lotus to be confounded with the poppy, is the resemblance which exists between the attributes of Isis and those of Ceres, to whom the poppy was consecrated †.

The *nymphæa lotus* and the *nymphæa nelumbo* are the two species of lotus described by Herodotus and Theophrastus. Both grew naturally in Egypt, and were cultivated in that country. It was the fruit of the cultivated *nymphæa lotus* to which Pliny gives the name of *lotometra* ‡.

A passage in Athenæus proves that the *nymphæa cærulea* is a third species of lotus. This author relates that Antinoian § crowns were made at Alexandria with the rose lotus, and that the blue were interwoven with these crowns. The flowers of these different kinds of lotus are very odoriferous, have great splendour and freshness, and must have been selected for making crowns. Heliodorus relates, that couriers who announced a victory in Meroe were crowned with lotus ‖. When Plutarch speaks of a crown of melilot which fell from the head of Osiris ¶, and when he classes that plant among those which grow in the Nile, he alludes to a crown of lotus. Athenæus relates, that the lotus was also called melilot **, and that it was formed into melilotine garlands. The same historian tells us also why the rose lotus was called the Antinoian. A poet presented the emperor Adrian, during

* Plin. Hist. Nat. lib. xiii. cap. 17.

† Virgil. Georg. i. ver. 212. Ovid. Fast. lib. iv. Theoc. Idyll. vii. ver. 153. Callimach. Hymn. Cer. ver. 45.

‡ Plin. Hist. Nat. lib. xxii. cap. 21.

§ Athenæi Deipnosoph. lib. xv. p. 677.

‖ Heliodor. Ethiop. lib. x. cap. 28.

¶ Treatise on Isis and Osiris.

** Athenæi Deipnosoph. lib. iii. p. 73.

his residence at Alexandria, with a rose lotus as a rarity, and said that this lotus, which had grown up in a country moistened by the blood of so terrible a lion, ought to be called the Antinoian. The lion of which the poet here speaks had ravaged a part of Libya, and had at length been destroyed by the emperor Adrian during a hunting excursion.

Independently of the plausible conjectures of several writers respecting the origin of the religious employment which the Egyptians made of the lotus, these plants, on account of their simple and natural properties, must have been very much celebrated in antient Egypt. This country being indebted to the Nile for its prosperity, its inhabitants considered as the signs of a great benefit the plants which grew in the waters of that river. The flowers of the lotus rise to the surface of the water when the Nile begins to increase, and announce the inundation, which is about to bring abundance along with it. Besides the names of *bachenin* and *naufar,* which the Egyptians give to the nymphæa, they call them also *araïs el Nil,* that is to say, which grow up in the Nile. These names certainly refer to the fertility about to be renewed by the presence of the waters.

The Egyptians collected the roots of the lotus when the waters of the Nile retired. At present they are seldom collected; but they multiply very much in the rice-fields, so that the peasants are obliged to pull them up after the rice harvest. They then sometimes eat these roots, which they call *biaro.* I saw some of them sold in the market of Damietta in the month of Frimaire, year 7: I tasted them, and found that their taste was not disagreeable. These roots are round, or somewhat oblong, and smaller than a common egg. The rind is black, and coriaceous: they exhibit tubercles, traced out by the base of the petioles or shoots. These roots in the inside are white and farinaceous; in the centre they are yellowish. After the inundation they remain sunk in the earth which has become dry; and the following year, when covered by water, they send forth leaves and small roots merely from the summit, which has a cottony appearance. The radiculæ penetrate laterally into the mud, where they produce tubercles which become similar to the former roots, and which multiply the plant. The Egyptians to collect the seeds washed them, after leaving the rind of the fruit to putrefy. This method is the only one that could be employed, otherwise these seeds would become mixed and desiccated with the parenchyme of the fruit. These seeds are very small, rose-coloured or gray on the outside, and farinaceous within. The antients compared them to grains of millet. I have heard

heard the peasants call them *dochn el bachenin*, that is to say, millet of bachenin: but they told me that they were of very little use. The roots and seeds of the *nymphæa lotus* and those of the *nymphæa cærulea* are similar. It is natural, then, to believe that the Egyptians not only made garlands of the blue lotus, but that they used it for food like the *nymphæa lotus*. This is proved by the Egyptian sculptures, since the blue nymphæa is often represented among the offerings of fruits in the grottos of Said, the paintings of which exhibit scenes of domestic life.

Of the two kinds of nymphæa, the Egyptians at present prefer that with blue flowers, which is often represented in the temples. Ebn il Bitar, an Arabian physician, who has written a treatise on plants, quoted by Prosper Alpinus *, distinguishes two kinds of *bachenin* or *nymphæa*, the best of which is called that of the Arabs. I observed that the peasants of the Delta gave the name of bachenin of the Arabs to the *nymphæa cærulea*, and that they set less value on the *nymphæa lotus*.

As the antients have made very little mention of the blue lotus, one might believe that it was brought to Egypt from the East Indies along with the rice, since it grows abundantly in the rice-fields of the Delta; but the paintings in the temples evidently prove that this plant is as antient in Egypt as the *nymphæa lotus*.

It is certain that the *nymphæa cærulea* exists in India. In the *Hortus Malabaricus* it is called *citambel* †. Rumphius considers it as a variety with blue flowers of the *nymphæa lotus* ‡. This nymphæa grows also at the Cape of Good Hope, and seems to be sufficiently distinguished by the following phrase of Breyn: *nymphæa flore cæruleo odoratissimo Capitis Bonæ Spei* §. A figure of it has been given by Andrews ||.

* Prosperi Alpini Rerum Egypt. lib. iii. cap. 10.
† Tom. ii. p. 53. tab. 27.
‡ Herbar. Amboin. tom. vi. p. 72.
§ Prodrom. ii. 26.
|| Botanists Repository, 197.

XLVI. *Memoir on ſome Peculiarities in the Anatomy and Phyſiology of the Shark, particularly reſpecting the Production of its Young.* *By Dr.* MITCHILL, *of New York**.

ALTHOUGH the generation and multiplication of animals have ſo long exerciſed the attention of philoſophers, the whole ſubject remains involved in intricacy and indiſtinctneſs. The maxim laid down by Harvey, and adopted by Linnæus, of *omne animal ex ovo,* that every animal proceeds from an egg, has, perhaps, been too generally received, ſince numerous facts, related by Mr. Bonnet, in his work entitled *Conſidérations ſur les Corps Organiſés*, evince the propagation of animals, in a great variety of caſes, from germs. Notwithſtanding the multiplicative powers of animals have been thus traced to eggs and germs, yet a popular diſtinction ſtill prevails to a conſiderable extent, of claſſing animals that propagate their ſpecies by means of genital organs, into oviparous and viviparous.

The great diſcovery of Haller, that the membrane covering the yolk of an egg was really a continuation of the membrane covering the inteſtines of the chick, had not only given countenance to the idea of the pre-exiſtence of the embryo, but has ſhown that animals, whether of the oviparous or viviparous kinds, really propagated their ſpecies in pretty much the ſame way.

Amidſt the different modes in which the embryo and its membranes are organized in different animals, there ſeems to be one caſe which has not been hitherto deſcribed with the accuracy and minuteneſs which its ſingularity deſerves: the genus of the ſqualus, which includes all the animals of the ſhark tribe, has ſome peculiarities which make theſe animals approach both to the oviparous and viviparous claſſes, without, however, belonging ſtrictly to either.

It had been known a long time, that the young of the ſhark had ſomething in their ſtructure conſiderably different from any other creatures, and figures of them have been given by Edwards in his Natural Hiſtory, and probably copied from thence into the Encyclopædia; but there has not been, as yet, any diſſection of theſe animals in this period of their exiſtence, nor any explanation of their phyſiology that I know of. It is the object of this ſhort memoir to explain the ſtructure and functions of the fœtus of a ſpecies of ſhark found frequently along the coaſt of New-York, in the waters of the Atlantic, during the ſummer months. About two years

* Communicated by the Author.

ago,

ago, as I was engaged in a fishing party in one of the bays on the south side of Long Island, a shark, between four and five feet in length, was taken in the seine, and secured in our boat, without receiving any material injury. Upon examination, this animal was found to be a female, whose uterus contained eleven young ones, of the size and figure represented in the plate.

Besides these young ones that had advanced thus far in their growth, there were contained a large number of ova within the body of this fish, in different degrees of evolution and size, some of them resembling the full grown eggs of the tortoise, and others similar to the smaller rudiments of eggs found in the ovaria of laying hens. On opening the uterus with a knife, the young fishes, as represented in the figure, were found each connected with an egg, dependent from that part of the belly which may be considered as the umbilicus, and appearing in the form of a very large hernia. This hernia, on examination, proved to be a true ovum, filled with yolky substance, evidently intended for its nourishment: and what was very remarkable, the young animal, though grown to a considerable size, and connected in this manner with its egg, had no connection whatever by means of an umbilical cord, a placenta, or by vessels of any kind, to the uterus of its dam; but it was so completely organized as to derive no sustenance to its body, nor to receive any renovation of its blood from its parent.

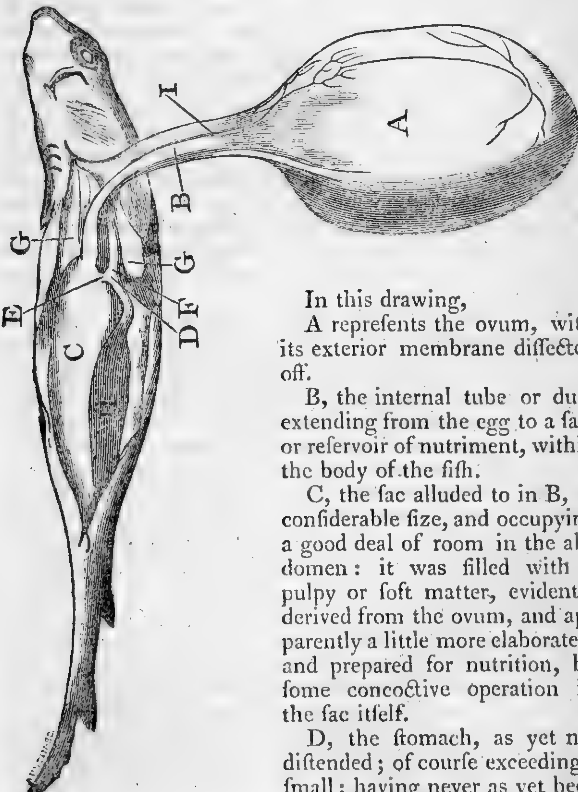
The membrane covering the egg contained most beautiful ramifications of blood-vessels. The arteries descending from the little fish could be seen sending off their branches over its whole exterior surface; and terminating in veins, to unite their trunks, and carry back their contents.

The singularity of all these appearances was considerably heightened by the capability of the little sharks, when cut out of the uterus, to live for a considerable time in the open air. The larger part of the brood had been left on the grass of the shore where the dam had been dissected; but the three which I reserved for examination lived, and exhibited, during the greater part of the time, brisk motion for almost two hours, although exposed to the temperature of a common atmosphere. During this time, while they lay before me on a plate, nothing of the kind appeared more beautiful or distinct than the branches of blood-vessels shooting through and running over the transparent membrane of the egg, the blood evidently appearing to acquire a brighter scarlet colour, whilst the fish was thus exposed to the air, than it had possessed during the immersion of the young animal in the fluid of the uterus. It seemed to have acquired more rapidly, and

to

to a greater quantity than before excluſion from its maternal membrane, the oxygen of the air to which it was expoſed; the union of which with the blood evidently brightened its colour, and imparted to it at the ſame time ſo much of a ſtimulant quality as to have ſhortened the duration of its life by exceſſive excitement.

The internal ſtructure of the fœtus of this ſhark may be ſeen in the plate. The diſſection was made by my colleague Mr. Poſt, profeſſor of anatomy in Columbia College; and the drawing was executed, immediately after, by Dr. Alexander Anderſon, of New York, in the preſence of the late Dr. Elihu H. Smith, Mr. William Dunlap, and Mr. Thorne.



In this drawing,

A repreſents the ovum, with its exterior membrane diſſected off.

B, the internal tube or duct extending from the egg to a ſac, or reſervoir of nutriment, within the body of the fiſh.

C, the ſac alluded to in B, of conſiderable ſize, and occupying a good deal of room in the abdomen: it was filled with a pulpy or ſoft matter, evidently derived from the ovum, and apparently a little more elaborated, and prepared for nutrition, by ſome concoctive operation in the ſac itſelf.

D, the ſtomach, as yet not diſtended; of courſe exceedingly ſmall; having never as yet been filled

filled with food derived from the mouth. In the plate will be seen a small passage or opening,

E, through which the alimentary matter in the sac, C, passes into the stomach, to be absorbed afterward by the lacteals of the intestines.

F, the œsophagus, of nearly the same size with the stomach.

GG, the two lobes of the liver.

H, the cloaca, or gut stretching towards the anus, and filled with the refuse matter of the alimentary mass.

I, the external membrane connecting the egg with the fish, cut through and turned back.

A species of shark, called *catulus major vulgaris*, is delineated by Edwards, but appears to be different from this. He has taken two views of the parent animal, and two more of the young. From the figures there given, it would seem that the same law of generation obtained as in this species. All the species probably breed in the same way.

There is a great variety in the multiplicative process of living beings. The female *rana pipa*, or Surinam frog, nourishes its young in certain cells or cavities in her back, and not in the womb. The *opossum* of this country supports her young appendant to the teats within the paunch or sac, called a false belly. The *kangaroo* of New Holland has somewhat of a similar structure and œconomy. More extensive and penetrating inquiries show the exceptions to the common mode of generation to be almost indescribably curious and diversified. We see no end to the variety of ways in which the perpetuation of the species is carried on. Even Spallanzani (5 *Viaggi alle due Sicilie*, &c. p. 46), though he went to the lake of Orbitello on purpose to examine the anatomy of the large eels which live there, could discover in them no appearance of sex.

When I published my Inaugural Dissertation in 1786, *Circa novi Genituram Animalis*, I was decidedly in favour of the hypothesis of pre-existent germs, and of the production of animals by their gradual evolution. All my numerous experiments on generation appeared at that time to lead to such a conclusion, though I have since had a good deal of reason to doubt the soundness of the inference; and the experiment now to be related, though it throws light on some part of the process, leaves the main question almost as unsettled as ever. In 1789 I ordered a large sow to be killed, immediately after having had intercourse with a male. On examining the genital organs, the blood-vessels of the vagina, uterus, fallopian tubes, and fimbriæ, were more than usually distended,

diſtended, and the fimbriæ in particular were in a condition of high redneſs and inflammation. Their fibres were lengthened, and reached ſo far as, on one ſide, to embrace the whole ovarium, and contain it within their incloſure. But the moſt remarkable appearances were in the ovarium itſelf. The ſow had borne pigs before. Some of the ova were of courſe exhauſted of their powers, and exhibited the appearance common in ſuch caſes. The whole ovarium was tinged with blood, and appeared to have been under the operation of a powerful ſtimulus. The entire ſubſtance ſeemed to have been enlarged. The ova partook of this enlargement, and all of them had evidently ſhared in the excitement and ſuffuſion. Some of them were but little ſwelled: ſome were ſo tumid as to be on the point of burſting: the membrane of others was ruptured, and the contents partly protruded; and, in ſeveral, the ſubſtance diſcharged from the broken ovum was fairly within the graſp of the fimbriæ. I imagined now I had before me proof ſufficient to determine the derivation of the fœtus from the mother. I accordingly examined the portions of ſubſtance diſcharged from one ovum, and extracted from others, with all poſſible care. But inſtead of finding an embryo, or any thing like the rudiment of a young animal, the little maſſes I had obtained reſembled coagulated blood more than any thing to which I can compare them, and appeared to have no more of organization or figure than is frequently ſeen in grumes or clots of that fluid.

XLVII. *On the Management and Improvement, by Tillage, of old Graſs Lands on a direct Clay, ſuch as is found in the Wilds of Surrey and Suſſex*.*

THE ſubſtratum to this ſoil being impervious to water, the ſurface muſt conſequently be continually ſaturated with moiſture. Many landlords on ſuch ſoils reſtrict their tenants, by covenants, not to till or plough up the old graſs lands, under an apprehenſion of the ſoil being exhauſted by tillage and cropping. In this unproductive ſtate the land lets for from five ſhillings to ſeven ſhillings and ſixpence an acre; and, being always full of ſtagnant water, the produce conſiſts of poiſonous weeds, water quitch, and a little ſour graſs. Two acres will keep one head of lean cattle alive for

* From Mr. Cloſe's Paper in the Communications to the Board of Agriculture, vol. iii. part 1. We gave a former part of this paper in our laſt Number, p. 167.

twenty

twenty fpring and fummer weeks. Some labour, and a confiderable expenfe, will be requifite to bring this ftubborn, fterile foil to a ftate of fertility.

I would firft recommend the furface to be pared and burned, and the afhes to be fecured dry upon the headlands of the fields, by a covering of earth, fods, or thatch. This operation muft be finifhed in the fummer. As foon as the autumnal rains have moiftened the foil fo as to enable a plough to turn a furrow feven or eight inches deep, this operation fhould be performed, forming each ridge with only two furrows, three feet from the centre of one ridge to the centre of the other. Then let the fcarifier, with three long tines, or teeth, pafs at the bottom of every furrow to loofen the foil five or fix inches deeper. Water furrows fhould be cut fo as to lay the land dry all the winter. Should the winter prove favourable, the tops of thefe ridges may be harrowed down with the fixed harrow, and the fcarifier paffed again through the bottom of the furrows, and the ridge formed over this deeply pulverized foil: if not, they muft remain until perfectly dry in the fpring. In tilling foils of all denominations in which the clay predominates, this general rule fhould be obferved; no injury will be fuftained from ploughing them when wet, previous to the winter frofts: but all the horfes on a farm had better remain idle than touch a furrow in the fpring, until the foil be perfectly dry. When in this latter ftate, harrow down the tops of the ridges; fcarify, with Mr. Cooke's fcarifier, the bottoms, and once more reverfe the lands, forming the ridges where the furrows were. Thus a depth of fifteen inches of finely pulverized foil will be obtained by two half ploughings, two fcarifyings, and two harrowings; at leaft the foil will be fo much opened to that depth as to admit the rain water to pafs freely. Every fhower will not make a pafte on the furface, neither will forty-eight hours fun form it into bricks. In fhort, by ftirring this land deep you avoid the injuries to which it was before expofed by exceffive wet or drought, and the foil will become healthy and productive. Should it not be fufficiently pulverized for turnips, fcarify, harrow, and roll, with a heavy roller only five feet long, until a garden tilth be obtained, leaving the land, when completely fine, on three-feet ridges. Previous to putting afhes on for drilling turnips, beat down three or four inches of the tops of the ridges with a fled, or beam of wood five feet long, annexed to the handles of Mr. Cooke's fcarifier. On this bed of finely pulverized mould in the furrows fpread the afhes; about eighty bufhels on an acre. This work will be eafily performed, as the horfe will walk in the furrow,

furrow, and each wheel of the cart will occupy another. As the horfes and the cart-wheels will make the foil in the bottom of the furrows immediately under the afhes compact, pafs the fcarificator through, as before directed, with only three long tines, or teeth, in the centre of the beam, then with one bout of the common plough reverfe the ridges and cover the afhes. Let the land continue in this ftate until the feafon fuit for fowing. Then with the fled, as before, level the tops of the ridges fo as to obtain a furface on each ridge eighteen inches wide. Mr. Cooke's drill will fow two of thefe ridges at a time, two rows of turnips on each ridge, nine inches from row to row, with an interval of twenty-feven inches. The turnips, as foon as the rough leaf appears, fhould be harrowed acrofs the ridges with the fixed harrow, then fcarified between the rows; and a few days after thefe operations they fhould be hand-hoed, leaving the plants in rows, fingle, and one foot apart. The intervals fhould be kept highly pulverized by alternate ploughings, horfe-hoeings, and fcarifying; being careful, before the autumnal rains commence, to throw all the mould from the bottoms of the furrows up to the ridges with a double mould board plough. This will not only keep the land dry and healthy all the winter; but, as the horfes will walk in one furrow, and each wheel of the cart will occupy another, the turnips may be carted to the bullock-fheds without poaching or injuring the land.

Knowing the difficulty in thefe clayey foils of obtaining a fine tilth for fpring fowing, I fhould recommend the fame ridges, after the turnips are drawn, and carted home, to be worked with the fixed harrow and roller, only fo as to obtain a fine tilth five inches deep; and then to drill two rows of oats, nine inches from row to row, leaving a furrow or interval of twenty-feven inches. When the oats are about two inches above the furface, harrow acrofs with the fixed harrow, fcarify twice in a place between the rows of oats, and roll the whole. After thefe operations, fhould weeds appear, horfe-hoe with the flat hoes. When the oats are harvefted, throw your ridges up high, like trenching in a garden, without reverfing them, keeping the bottoms of the furrows clean from mould, and laying the land perfectly dry. In the firft froft cart about twenty loads per acre of good horfe or bullock dung, not too rotten, into the furrows; fpread it; and as foon as the froft is out of the land, harrow or fled down the tops of the ridges, reverfe them, and cover the dung: the firft dry weather in February or March, fled down the tops of thefe ridges, to obtain a furface of eighteen inches, and drill two

rows of beans on each ridge, nine inches from row to row, and twenty-feven inches interval. Scarify, horfe-hoe, and plough between the intervals, fo as to keep a fine tilth, and to deftroy the weeds. When the beans are fit for harvefting pull them, and when carried off the land pulverize the tops of the fame ridges by fcarifying, rolling, and working with the fixed harrow; and, if any furface-weeds appear, fkim the land with the fcufflers; and by repeating thefe operations prepare the fame ridges for wheat, and drill two rows on each ridge nine inches from row to row. In the fpring harrow acrofs, &c. as directed for the oat crop. Should the farmer wifh to fubftitute cabbages for turnips, one row fhould be planted on each ridge, fetting the plants two feet and a half from each other in rows, with three-feet intervals. In this fucceffion of crops, viz. turnips or cabbages, oats or barley, beans, peafe and clover, and wheat, even this naturally fterile foil will be in a conftant ftate of improvement: and if the vegetable crops and ftraw be expended in the moft advantageous method upon the farm, the land may be dreffed with fourteen loads per acre twice in four years, viz. for the turnip or cabbage crop, and for the bean, pea, and clover crop. I fhall not, therefore, limit the number of years for keeping it in tillage to any precife term, as it appears to me immaterial; but proceed to point out the beft method of fecuring a good meadow whenever the occupier may wifh it *.

We will fuppofe the land cropped eight years in the rotation of crops before recommended, and at the expiration of that term, a wheat ftubble. The firft operation I fhould recommend would be to drain the land fo as to take off the furface water, for nothing more can be effected by draining thefe lands, as they will hold water like a bucket; and were the drains cut ever fo deep, and only fix inches from each other, the water would not draw from one to the other. The method I fhall propofe is eafy and efficacious, and the expenfe very trifling. I fpeak with confidence, as almoft the whole parifh of Hitcham, in Suffolk, where twenty years back it was thought impoffible to grow barley, now produces fine and heavy crops of that grain, by the furface water being taken off expeditioufly. Open furrows in the wheat ftubble with the common plough, about five yards from each other, and as deep as the land was ever ploughed and fcarified. Then with a narrow gripping-fpade, twenty inches long,

* Old grafs lands converted into tillage, though they might be ploughed by a judicious fyftem of cropping for any number of years, if naturally crude and unproductive, fhould not, I think, be fown with grafs feeds in lefs than eight years.—*Note by Mr. Clofe.*

and only two inches and a half wide at the top, and one at the bottom, open a drain sixteen inches deep; fill this with the wheat haulm, ramming it down as hard as possible; the price two shillings and sixpence per score rods, to dig and fill up. It is, I presume, unnecessary to observe that these and all other drains should not be cut in a line with the natural fall of the land, but in an oblique direction. No bushes should be used, as, when these begin to decay, pieces of them will fall across these very narrow drains, and obstruct the course of the water. The straw or haulm, when it decays, sloughs off, and the water passing through the clay forms an arch, which will last many years. There are drains of this sort still open in Hitcham parish, which have been cut more than twenty years. Having thus freed the land from the noxious moisture arising from stagnant water, with one bout of the plough throw the land on to three-feet ridges, and before January reverse these. In the spring, when perfectly dry, harrow down the ridges with the fixed harrow, so as to make a complete fallow*; then dress with lime or compost, and baulk the land, viz. give it half a ploughing, leaving it in narrow ridges, so as it will harrow down quite level and fine without any furrows appearing. In the beginning of August sow thirty-two bushels per acre of the sweepings of hay-chambers, where only good old meadow hay has been used without any broad clover and rye-grass, five pounds of Dutch clover, and five pounds of trefoil; harrow the seeds three or four times over, and you may expect two tons or two tons and a half of hay per acre the first year; which will pay all the expenses, and leave the land improved from five shillings or seven shillings and six-pence per acre, its original value, to fourteen shillings or sixteen shillings per acre.

And now, gentlemen, as you seem particularly desirous of obtaining information from actual experiment, permit me to assure you, that though I have not given you, neither is it in my power, an exact detailed account of an experiment I made on fifty acres of land in the wilds of Surrey, yet the great outlines of the plan, and the general result, correspond with my actual practice. I purchased nearly 600 acres of land in that county for three thousand six hundred pounds; the stock and crops were valued to me at about five hundred pounds, and the rent of the major part of the land estimated at five shillings per acre. After farming it some years,

* The scarifiers would be dangerous instruments to use after the drains are cut, as they, by penetrating too deep, might pull down the sides of the drains, and bring the haulm to the surface.——*Note by Mr. Close*

I let

I let the whole at ten fhillings per acre; the tenant paid me for the ftock and crops two thoufand and eighty pounds; and I afterwards fold the eftate to him at nearly double the price I gave for it, having previoufly paid myfelf the greater part of the expenfes for the improvements I had made. Fifty acres of the land will more particularly elucidate this fubject. Part of it was broken up from old four grafs, not worth five fhillings per acre, and part of it was old tillage land, which had been limed and cropped until it literally would produce no weeds except the fow-thiftle. After treating thefe lands, as nearly as I can recollect, according to the fyftem I have recommended, I fallowed and dreffed them with a compoft of lime and earth, and fowed the quantity of feeds I have mentioned, at or near the feafon recommended, and the produce was eftimated at two tons and a half of hay per acre; and the fifty acres of land which were valued at five fhillings per acre when I purchafed them, were eftimated at fifteen fhillings per acre when I fold the eftate. I did not furface-drain the land, as I was not then acquainted with the fyftem, neither did I pare and burn, but dreffed with a compoft of lime and mould. The fyftem I have recommended differs from my actual experiment in thefe two circumftances. But the furface-draining has proved effectual in the parifh of Hitcham, and feems to carry conviction with it; and by paring and burning, as good a dreffing as the lime may be procured, at a much lefs expenfe. Many may object to paring and burning and ploughing thefe lands into what is termed, by the farmers, the dead earth. I am of opinion thefe operations are pernicious, on really thin-fkinned foils, when the immediate fubftratum is much inferior to the furface. But in the foil I have been treating of, the only difference between the furface and the fubftratum confifts in the former having been expofed and pulverized, and the latter having remained impregnated with ftagnant water, and never turned up fo as to derive any benefit from the viciffitudes of the atmofphere. By paring and burning you deftroy the furface-weeds, and obtain a cheap dreffing; by ploughing the land deeper than ever it was ploughed before, expofing it to a winter's froft and fummer's fun, and dreffing it with afhes or lime, you obtain a depth of fweet mellow foil, not eafily injured by wet or drought, and adapted to all the purpofes of vegetation. To prove the utility of moving thefe clay foils fourteen or fifteen inches deep, let any one cover a pewter difh, or any fubftance like the fubftratum of thefe lands, impervious to water, with earth one inch deep, and expofe it to a trifling fhower, and the whole mafs will

become a quagmire; let another dish be covered with the same soil fifteen inches thick, and it is evident it will require fifteen times the number of cubic inches of water to put this into the same boggy state. The former also by twenty-four hours dry weather will become as hard as a brick, when the other will only have a slight incrustation formed on the surface.. Supposing this effect to be produced on your field, by passing the fixed harrow once across the land, it will be put into a state of fine pulverization. By drilling on three feet ridges, you keep the land in a dry healthy state; and by sowing your spring crop on the same ridges, you obviate the only objections to growing green winter crops on wet lands, viz. cutting up the lands by carting off the crop, and the impracticability of afterwards preparing them for spring sowing. In carting, the horses walk in one furrow, and the wheels track in two other furrows; the tops of the ridges are always dry; and the fixed harrow passing twice in a place, will prepare such lands for sowing, before the farmers in the common mode of management, without a crop of green food, can put a hoof on their lands. Should surface weeds appear before sowing, Mr. Cooke's scufflers, or broad shares fixed in the scarifying-beam, should be passed through the land.

[To be continued.]

Erratum.—In the last Number, p. 168, last line, for Cole read Close.

XLVIII. *Some Account of* George Pearson, *M. D. F. R. S. &c. &c. with a Portrait from an original Painting.*

WE are sensible that an editor of the biography of living persons should consider himself as in a very delicate situation, and the more respectable the character who is his subject, the greater should be his care; for utterly unmerited eulogy, from motives of interest or vanity, is so usual, that any praise at all, or at least exceeding what is already generally conferred and confessedly due, must be offensive to a man of intrinsic merit. But these considerations need not restrain an editor from gratifying the curiosity of the public, who may not personally know a man of eminence, by a statement at least of the departments in which he has been occupied, and a recital of his published literary labours.

Dr. Pearson graduated at Edinburgh at a very early period of life, and of course he must have previously studied a certain number of years in that university. An extract from his inaugural dissertation, *De Putredine*, may be found in

in the Medical Commentaries for 1775. Several communications on medical and philosophical subjects, subsequently to this period, are inserted in that annual work.

In 1784 Dr. Pearson published a treatise on the Buxton waters, principally to make known his discovery that the gas which issues from them spontaneously is not, as was believed, fixed air or carbonic acid, but phlogisticated air or azotic gas. Dr. Saunders, in his late treatise on Mineral Waters, has given due credit to the author for this discovery, as well as for his able analysis in general.

In the year 1788 Dr. Pearson published in several journals his account of the salt composed of phosphoric acid and soda, recommending it as a purgative which possesses no disagreeable taste, and is equally mild with any other of the cathartic salts. It is one of the articles in the Edinburgh Pharmacopæia of 1791, under the title of Soda Phosphorata: since that time it has been in general use.

In the Philosophical Transactions for 1791 we find Dr. Pearson's masterly and at that time unrivalled analysis of the James's Powder. Immense savings have been made by individuals since this discovery, especially in the navy, to the amount, as the late Dr. Johnson, one of the Commissioners of the Sick and Hurt Office, asserted, of several thousand pounds a year.

In the Philosophical Transactions for 1792 is a paper entitled, Experiments made with a View of decompounding Fixed Air or Carbonic Acid, by Dr. Pearson. In 1789 M. Lavoisier showed that carbonic acid might be composed by uniting carbon to oxygen: but the author in the present paper says, "The honour of the first analytical experiments on carbonic acid is due to Mr. Tennant, F. R. S." who obtained phosphoric acid and carbon by passing phosphorus through red-hot carbonate of lime, or marble powder. Whatever doubts were entertained of this fact, as stated by Mr. Tennant, they were entirely removed by the decisive experiments of Dr. Pearson.

In the Philosophical Transactions for 1794 is inserted Dr. Pearson's paper on the wax-like matter called white lack, in which he discovered a new acid called by him *laxic acid*, according to the new nomenclature of chemists.

In the same work for 1795 is Dr. Pearson's paper on the steel supposed to be made directly from the ore by the Hindoos, called *wootz*.

In the following year is our author's paper on the composition of the hard and strong metals of the antients, which he determines to have been copper united to tin, as demon-

 strated

ſtrated by his analyſis of ſpecimens of antient metals, furniſhed by the preſident of the Royal Society the right honourable Sir Joſeph Banks.

In 1797 the Philoſophical Tranſactions contain Dr. Pearſon's communication of experiments on the gas produced by paſſing the electric ſpark through water; which he determines to be the mixture of oxygen and hydrogen gas, as demonſtrated by firſt ſeparating the oxygen by nitrous gas to produce nitrous acid, and then inflaming the reſidue after adding oxygen, and thus compoſing water.

In the Philoſophical Tranſactions for 1798 is publiſhed the author's paper on urinary calculi of man and brute animals; in which he ſhows that the ſublimed acid of Scheele and the precipitate examined by the French chemiſts are not the ſame ſubſtance; and that the latter does not poſſeſs acid properties, but thoſe of an oxide, for which he propoſes the denomination *uric oxide*, a name ſince generally adopted.

In 1794 Dr. Pearſon publiſhed the new French Chemical Nomenclature, with explanations ſuited to the Engliſh reader, and additions according to ſubſequent improvements in chemical philoſophy. In a ſecond edition of this work the author has made very conſiderable additions, by giving new tables of affinities, and tables of double and ſingle elective attractions.

Among the medical diſſertations and papers of the author, the prominent ones are thoſe on the Cow-pock. The firſt of theſe, in 1798, contains a great collection of facts of this diſeaſe; and it immediately ſucceeded the work of Dr. Jenner, the firſt profeſſed promulgator of this diſeaſe. This is neither the fit place nor time for a compariſon of what has been effected by theſe two gentlemen; and if it were ſo, it would not be adviſable to interfere. We honour and reſpect both of them as public benefactors. We have already ſet forth Dr. Jenner's merits in our Journal, vol. xiii., and we have given an abridged account of Dr. Pearſon's late work, in 1802, in the ſame volume. The work entitled The Report of the Cow-Pock Inoculation from the Practice at the Vaccine Inſtitution in 1800, 1801, and 1802, as read at a general meeting of the ſubſcribers February 7th laſt, which we had the pleaſure to hear read, will give the beſt account of the merit of Dr. Pearſon, in conjunction with the other phyſicians, in eſtabliſhing that inſtitution, and carrying on the inveſtigation of the new diſeaſe, occupied as he is in extenſive practice as a phyſician, as a teacher on the different branches of phyſic, and as phyſician to a large London hoſpital. But after all it muſt be reſerved for poſterity to aſſign the due place

of

of the introducers of the new beneficial inoculation in the temple of Fame; for it will be ſome time before the prejudices excited by jealouſy and intereſt ſhall be extinguiſhed.

Dr. Pearſon was elected phyſician to St. George's hoſpital in 1787; and how ſerviceable he has made it to his ſchool of medicine is beſt evinced by his numerous pupils, and the proficiency they make in their ſtudies.

Dr. Pearſon's elementary books on medicine are printed, and in the hands of his pupils, but not yet publiſhed.

XLIX. *Notices respecting New Books.*

An Eſſay on the Relation between the Specific Gravities and the Strengths and Values of Spirituous Liquors, with Rules for the Adaptation of Mr. Gilpin's Tables to the preſent Standard, and Two New Tables for finding the Percentage and Concentration, when the Specific Gravity and Temperature are given. By Atkins *and Co.* 4to, 1803.

THE preſent work is drawn up in ſuch a maſterly and ſcientific manner, that we ſhall, as ſoon as we can find room, preſent ſome large extracts from it. In the mean time we inſert the Preface.

"If the ſubject of the following pages were regarded merely with reference to thoſe immediate practical conſequences which reſult from its conſideration as connected with a great branch of the revenue, and ſtill more with the intereſts of commerce, it muſt neceſſarily be conſidered as one of the higheſt importance. Theſe, however, are by no means the only points of view in which it preſents itſelf: it is intimately related to the correct appreciation of our weights and meaſures in general, the neceſſity of which appears to be univerſally admitted.

"It would certainly not be expedient at this day to change thoſe venerable ſtandards, by which, as belonging to the firſt commercial nation, the traffic of the world is in a great meaſure guided and regulated; but it muſt have occurred to every man who reflects on the ſubject, that, in the preſent ſtate of commerce and ſcience, it would at leaſt be convenient that we ſhould poſſeſs ſome better definition of a yard-meaſure than that which William of Malmſbury gives us, when he ſtates that it is the exact length of the arm of King Henry the Firſt; and ſome more correct deſcription of a pound-

pound-weight, than that it is as heavy as 7680 grains of wheat taken from the middle of the ear*.

" These ideas were naturally suggested to the minds of the authors by the necessity which they have been under, in the course of their trade, of deciding on which of the various discordant authorities they should found their estimation of the weight of given measures of different fluids, and of the relation which these measures of capacity bear to the linear measures of the country; and there cannot, perhaps, be a stronger proof of the propriety of a declaratory act to settle these matters, than that there should still remain something to be assumed with respect to every one of them. This important measure is, however, as the writers of this essay believe, now in the contemplation of the government.

" It is stated in § 16, that they have estimated the wine-gallon at 231 cubic inches, the pound avoirdupoise at 7000 grains troy, and the relation between troy weight and linear measure to be such, that the weight of a cubic inch of distilled water at 60°, when weighed in air at 60°, shall be equal to $252\frac{1}{2}$ of the same grains.

" The assumption with regard to the wine-gallon is founded on the established practice of the Boards of Customs and Excise to consider it as of the content which is here given; it being sufficiently known, from a very accurate experiment which was made on this subject May 25, 1688, in the presence of the Lord-Mayor, the Commissioners of Excise, Dr. Halley, Mr. Flamstead, and other men of science, that the old wine gallon in Guildhall really contains only 224. The former, however, is, perhaps, at the present day, the legal wine-gallon.

" The supposition with respect to the relation between avoirdupoise and troy weight, is chiefly founded on a kind of tacit agreement amongst the majority of scientific men at present to consider the avoirdupoise pound as equal to 7000 grains troy; and that which is, perhaps, of still more practical effect with regard to it,—the opinions of the best informed amongst our scale-makers: for, whether it arises from the smaller value of the articles which are weighed by the former, and its consequent less minute subdivision; from its introduction by custom rather than by statute; or from whatever other cause it may be derived, it appears to have been

* " Per ordinacionem tocius regni Anglie fuit mensura domini regis composita, videlicet, quod denarius qui vocatur sterlingus rotundus et sine tonsura ponderabit triginti duo grana frumenti in medio spice. Et uncia ponderabit viginti denarios. Et duodecim uncie faciunt libram London."
Stat. "De Ponderibus et Mensuris." 31 Ed. I.

always

always subject to more uncertainty than the latter. Mr. Ward tell us, in his Mathematics, that he found, by a very nice experiment, that the pound avoirdupoise weighed $6999\frac{1}{2}$ grains troy, and yet we find, from the Report on the Weights of Europe in general, in the Memoirs of the French Academy of Sciences for 1767, that the ratio between the avoirdupoise and troy pounds, which M. Tillet had obtained for the purpose, was that of 7004·5 to 5760.

"The appreciation of the weight of a cubic inch of distilled water is principally founded on the experiments of Sir George Shuckburgh Evelyn, Bart., described in the Philosophical Transactions for 1798; from a mean of which it follows*, that the cubic inch of distilled water at 60°, under the circumstances described in § 16, weighs 252·506 grains of the standard troy pound made for the Committee of the House of Commons in 1758, or 252·8_6 if weighed in vacuo.

"A variety of motives concur to induce the authors to take these as standard experiments. All the older attempts of this kind are of no value whatever, having been made with water which was not distilled, and under other circumstances which render them liable to innumerable errors: even the celebrated experiment of Mr. Everard in 1696 was made with undistilled New River water. The only ones, perhaps, which are at all to be compared with those of Sir G. S. Evelyn are those of Dr. Robison, and the French Commissioners of Weights and Measures.

"The former gentleman weighed a cylinder whose height and diameter were each 6 inches, taken, as he says, from a most accurate copy of the Exchequer standard, several times in distilled water at 55°, and found that it lost 42895 grains of its weight without a variation of 2 grains in the whole. Now, the solid content of the above body being $6^3 \times .785398$, or 169·646 cubic inches, a cubic inch of water weighs in air, according to this experiment, 252·85 grains at 55°; or, by Mr. Gilpin's Tables, exactly $252\frac{1}{4}$ at 60°.

"The authors of this essay are, however, induced to prefer the experiments of Sir G. S. Evelyn to that of Dr. Robison, principally for the following reason:—He does not tell us whether his weights had been immediately and accurately compared with any of the parliamentary standards. The adjustment of the best weights is generally thus performed:—They are, in the first place, filed to something near the required weight; then ground on a stone, and afterwards po-

* See Philosophical Journal, Octavo Series, vol. iv. p. 35 (No. for Jan. 1803.)

lished. Now, it very frequently happens, that some of these operations are carried a little too far, and one or two of the weights rendered somewhat too light; and when this is the case, unless the workman can be absolutely depended on, the whole set will infallibly be spoiled; for, instead of making new ones to supply their place, he will, nine times in ten, prefer the adjusting the others to them; conceiving it to be of more consequence that they should all agree, than that they should be accurately of any particular weight. When weights are successively copied from each other a number of times, the last of the series will therefore frequently be lighter than the first, and sometimes very considerably so.

"For the appreciation of the weight in troy grains of a cubic inch of distilled water at 60°, from the experiments of the French commissioners of weights and measures, we have the following data.

" We are told by the *Instruction sur les Poids & Mesures*, prefixed to M. Brisson's *Traité de Physique*, and which is certified by the commissioners to be " exactly founded on the results obtained and recorded by the said commission," and in several other works, that they weighed distilled water in nine different cases at various temperatures, in air and in vacuo. We will, however, select the case which they have thought proper to assume as the basis of their standard of weight, viz. that in which the weight of water is taken at its maximum of density (or about the temperature of 40° of Fahr.) and in vacuo; under which circumstances they inform us that the cubic decimetre weighs 2 pounds 5 gros and 35·15 grains, or 18827·15 grains of the *poids de marc*.

" This, according to M. Tillet's appreciation of the English troy pound, which he makes equal to 7021 of these grains, is equal to 15445·7 grains troy.

" Now, we find from the report made to the Mathematical and Physical Class of the National Institute on the 27th of December 1801 *, relative to a comparison of the metre with a scale of M. Pictet's, which was exactly similar to that of Sir George Shuckburgh Evelyn, that this measure is equal to 39·38272 inches of that scale when at 32°; or, correcting for temperature according to General Roy's table of the expansion of his brass scale, in the 75th volume of the Philosophical Transactions, equal to 39·3712 inches of the same scale when at 60°; the French platina and iron standards, when at the freezing point, indicating the length of the metre.

" The cubic decimetre, therefore, is equal to 61·02896

* Philosophical Magazine, vol. xii. p. 229.

cubic

cubic inches of Sir G. S. Evelyn's ſtandard at 60°, and 15445·7 ÷ 6·02896 is equal to 253·088; the weight in troy grains of ſuch a cubic inch of water at its maximum of denſity and in vacuo, according to the experiments of the French commiſſioners.

"Now, according to Mr. Gilpin's Tables (Phil. Tranſ. for 1794, p. 382), the ſpecific gravity of water in this ſtate is to that which it poſſeſſes at 60° as 1000·94 to 1000. But 1000·94 : 1000 : : 253·088 : 252·851. The weight of a cubic inch of water, therefore, according to this method of calculation, would, if weighed *in vacuo* at 60°, be = 252·85 grains; and if weighed in air at the ſame temperature, under the preſſure of $29\frac{1}{2}$ inches, = 252·55; being within $\frac{1}{5000}$th part of the weight deduced from Sir G. S. Evelyn's experiments.

"It was thought indiſpenſable thus to ſtate the hypotheſes on which the authors have proceeded with reſpect to their calculations, and conſequently with regard to the inſtruments which they have hitherto manufactured for aſcertaining the relative ſtrengths and values of liquors of various deſcriptions, and particularly thoſe which conſtitute the ſubject of theſe ſheets. The variation of denſity in alcoholic compounds is a circumſtance which is not only of importance to the merchant, the ſpirit dealer, and the revenue officer; to the philoſopher, who is engaged in the inveſtigation of the nature and progreſſion of thoſe forces by which the conſtituent particles of matter are connected with each other, it muſt alſo afford matter of intereſting contemplation. It is, therefore, of no inconſiderable conſequence that every thing relating to it ſhould be eſtabliſhed on the beſt authorities and the ſureſt foundations, and that the public ſhould be enabled to judge of the degree of credit which is to be given to thoſe who endeavour to elucidate ſo important a ſubject."

L. *Proceedings of Learned Societies.*

GALVANIC SOCIETY, PARIS.

THIS ſociety has organized a commiſſion of experiments. Thouret is elected preſident; Aboville, vice-preſident; and Izarn, ſecretary.

M. Winckler gave an extract of ſeveral obſervations on caſes of deafneſs cured by M. Schaub, of Caſſel.

The ſenator Abrial communicated a memoir of M. Pfingſten, director of the inſtitution for deaf and dumb at Kiel,

tending to prove that Galvanifm is of very little ufe in deafnefs.

M. Mojon gave an account of fome experiments which feem to prove that Galvanifm is proper for retarding the putridity of animal matters.

M. Nauche the prefident, and Pajot-Laforêt, communicated a new Galvanic phænomenon. Having fubjected to the action of the pile frogs expofed to a temperature of ten degrees below zero, they obferved, that repeated contact of the conductor communicating with the copper pole produces the development of a whitifh mucous fluid, exceedingly abundant in the liver, lungs, and particularly the nerves and the heart; not very abundant in the mufcles, the inteftines, and none in the integuments; while the conductor in communication with the zinc pole produces no development of this fluid, and feems rather to caufe that which has been produced to difappear.

C. Gautherot has made a feries of experiments tending to prove that electricity is developed in the ratio of the furfaces.

C. Nauche the prefident, with his fellow-labourers Bonnet and Pajot-Laforêt, has been able, by means of two *homogeneous* metallic conductors, to draw off the electric fluid from the brain and fpinal marrow of an ox recently killed, and to convey it to the thighs of a frog, where it produced mufcular contractions. This operation fucceeded alfo in the palpitating mufcles, and could be continued only a quarter of an hour after death. The fenator Lamartillière gave an explanation of the difengagement of mucous matter by the poles; and fhowed that it arifes from a chemical decompofition.

C. Izarn gave an account of the conftruction of a pile invented by C. Alizeau, in which, inftead of difks moiftened with a faline folution, a ftratum of moiftened falt is employed, and which can produce its effects for a month without being cleaned.

The Commiffion of Medical Application, confifting of Guillotin, Dadaujon, Petit-Radel, &c. have made a great number of experiments on afphyxia by ftrangulation.

The application of Galvanifm to difeafes, fufpended in confequence of the winter feafon, is going to be refumed at a place deftined for the purpofe in the School of Medicine, and in the private laboratory of the fociety.

LI. *Intel-*

LI. *Intelligence and Miſcellaneous Articles.*

ANTIQUITIES.

GENERAL REYNIER having preſented to the French National Inſtitute a tunic and the remains of ſome antient veſtments found near Sakara, in Egypt, the three claſſes appointed commiſſioners to give in a report on theſe curious articles. A very exact idea may be given of this tunic by comparing it to the tunics worn by the deacons and ſubdeacons of the Roman catholic church, if we ſuppoſe the latter to have long cloſe ſleeves, as was formerly the caſe. It is ornamented with embroidered pieces, ſome of which deſcend from the ſhoulders; others are applied to the ſhoulders, and at the bottom before and behind: two pieces of the ſame kind ſurround the extremity of the ſleeves. The colour of the ſtuff is a ſouci yellow, and the embroidery is puce colour, or dark brown. The deſign is of little importance, and has no relation either to natural objects, to hieroglyphics, or to written characters. The ſtuff has been wove in the loom, but the embroidery ſeems to have been executed according to the proceſs of tapeſtry *au petit point*. In regard to the nature of them, chemiſts have found that the yellow ſtuff of the tunic is animal matter. In regard to the embroidery, the yellow tiſſue or ground is vegetable matter, and the brown thread, animal matter.

General Reynier was not able to procure any further information from the inhabitants of Sakara, who ſold him this tunic, except that they had found it with other articles in a pit filled with ſand which they had dug up.

No particular account can be given of the time when this tiſſue was wove, nor of the perſonage to whom it belonged. In the report made on it to the Inſtitute, the author ſhows that it belonged neither to a Macedonian nor a Greek eſtabliſhed in Egypt, as it has ſleeves which deſcend to the wriſt, whereas the Grecian tunic had no ſleeves, or ſleeves ſo ſhort that they reached only to the elbow; but it appears certain that the Macedonian tunic was not different from the Grecian. The Macedonians were diſtinguiſhed from the other Greeks only by their head-dreſs (*cauſia*) and their chlamys. The tunic of Sakara belonged then to an Egyptian. But the point is to determine at what period. The author of the report only ſays, that it cannot be older than the time when Thebes was abandoned. The grottoes of Sakara, which are

at

at the diftance of a few miles from Thebes, near the ruins of Thebes, were no doubt dug about that time. It was in the fixth century before the Chriftian æra that Cambyfes ravaged Thebes, and plundered it of its riches and monuments. The moft remote period, therefore, which can be affigned to the time when the tunics were wove is the fifth or fourth century before Auguftus.

It is impoffible to fay any thing more correct in regard to the perfonage who wore it. We are told by Herodotus that the Egyptian priefts wore a fingle veftment of linen, and fhoes of papyrus. The priefts of Ifis at Rome were called the troop clothed in linen, *linigera turba*. Pythagoras, who imitated them, made no ufe of woven ftuffs made from animal matters. The tunic of Sakara was therefore not worn by an Egyptian of the facerdotal order.

It did not form part of a female drefs, for we are told alfo by the father of hiftory that the Egyptian women were clothed in linen. The men ufed alfo fimilar veftments; but they wore above thefe tunics white woollen veftments. "But," Herodotus adds, "they do not wear woollen veftments in the temples, and they do not bury their dead in dreffes of that kind; they would be confidered as indecent."

The yellow colour of the tunic, if not the effect of antiquity, would be no proof of its not having belonged to an Egyptian; but if it be the effect of art, we may fuppofe that it was the diftinguifhing mark of fome dignity. In a word, the only thing certain which can be faid of this Egyptian veftment is, that it was not conveyed with the body of a deceafed perfon to the grottoes of Sakara, which ferved as tombs, becaufe it was repugnant to the ideas of the Egyptians to be interred in wove woollen cloth. It muft therefore have been depofited with other riches which the proprietors wifhed to fecure from the rapacity of the enemy.

C. Mongez has communicated to the Inftitute a memoir on fome antient medals and other articles difcovered near Aurillac, in the department of Cantal. Some workmen digging in a meadow found the portion of a circular inclofure confifting of a double wall. It was about fix feet in diameter, and four feet eight inches in height; but rofe very little above the furface of the meadow. The interior wall was of baked brick, exceedingly beautiful, circular, and with the joinings tending to the centre. This interior wall was furrounded by another of dry ftones, deftined, no doubt, to fupport the earth. No traces of a covering appeared, and it is probable there never was any.

In digging in this inclofure, and demolifhing it, there were firft

first found medals of gilt bronze of all the Roman emperors down to Commodus, Otho excepted; which proves that in the second century bronze medals of that prince were exceedingly rare, and that they had not then, perhaps, been carried into Gaul. Along with the small vessels of baked earth which contained these medals, there were dug up some smaller ones which contained aromatic substances. The workmen took them for tobacco; but finding by the taste that they were deceived, they threw them away, and carefully washed the vessels which contained them; so that neither the nature of these aromatics, nor even the odour which the vessels would have retained, could be known. Two small bits of very white moulded clay were also dug up: one represented a dog, the legs of which were broken; the other was a female bust, but the remainder of the body was destroyed by the digging. A clasp of bronze, and a glass ring of so large a size that it could be worn only on the thumb if it served for a ring, were also dug up.

The circular form of the inclosure discovered near Aurillac induces C. Mongez to conjecture that it might have been used for burning dead bodies, and that it was an *ustrinum*, such as the circular inclosure of earth in which the body of Augustus was burnt, and which was religiously preserved near his mausoleum, still in part existing; and such as the inclosure of the same form discovered in 1763 near Placentia, in the ruins of the antient Veleia, which appears to have been buried by the fall of a mountain, and which Winckelmann found to be an *ustrinum*. Some of the inscriptions on antient sepulchral stones of the Romans announce an express prohibition to construct an *ustrinum* near a monument. The reason of this prohibition has not yet been examined. After mentioning the law of the twelve tables, which forbade the burning of bodies nearer any edifice than the distance of sixty feet, without the owner's consent, C. Mongez is of opinion that this prohibition supposed some edifice to be in the neighbourhood, the proprietor of which insisted on the rigorous execution of the law.

In regard to the small female bust found near Aurillac, C. Mongez observes, that Montfaucon has given engravings of four female figures of the like kind. They were all of that kind of argillaceous earth called tobacco-pipe clay; the workmanship was coarse, and they had all been moulded: one of them was found in 1710, in digging in the abbey of Saint-Lomer, at Blois. It was deposited in a small grotto containing the half-burnt bones of animals, among which were found the thigh-bone of a horse and the tooth of a dog. The Gauls were

were accuſtomed to throw into the funeral piles of their dead, thoſe animals they had been fondeſt of, ſuch as dogs and horſes. There is reaſon, therefore, to conclude that the grotto of Blois was a burying-place of the Gauls, and, by analogy, that the incloſure of Aurillac belonged to the ſame nation. The female buſt found there exhibits the ſame characters as the figures publiſhed by Montfaucon; and beſides, there was found along with it a figure of a dog of the ſame ſubſtance and workmanſhip.

Theſe female figures have been ſo often dug up in the ſepulchres of the Gauls, and the ſtyle, the workmanſhip, and materials have ſo great a reſemblance, that one cannot help ſuppoſing that they muſt have been depoſited there from the ſame motives. C. Mongez is of opinion that they may have repreſented the principal mother goddeſſes in general, and thoſe in particular whom the deceaſed whoſe aſhes repoſed in theſe tombs had adopted as their protectors. A great deal has been written on the mother goddeſſes mentioned in the ſepulchral inſcriptions of the Romans: *Diis matribus ..... matronis*, &c. As bas-reliefs repreſenting three females, ſometimes ſtanding and ſometimes ſitting, holding fruits, cones of the fir-tree, and cornucopias, were ſometimes added to ſuch inſcriptions; the mother goddeſſes were at firſt taken for rural deities: but one of theſe monuments was found in the city of Lyons, and on others they are called the mothers of Galicia, the mothers of the Gabii, &c. Their protection therefore was extended to cities and provinces alſo. Keyſler thinks that they were thoſe druid females for whom the Gauls entertained ſo great a veneration; but this opinion is contradicted by monuments of the ſame kind, conſecrated in countries at a very great diſtance from Gaul. Others conſidered the mother goddeſſes as the three Parcæ or Fates; but it is not certain that the Parcæ ever formed a part of all the nations among whom the deities in queſtion were worſhipped: beſides, the latter had their proper denomination, *Fata*. In the laſt place, Barrier propoſed a ſtill more probable opinion reſpecting the mother goddeſſes: he ſuppoſed them to be deities common to ſeveral nations, and that their ſurnames denoted the places where they were worſhipped.

To this may be added, that the women acknowledged them as their ſpecial protectors; for we read on two inſcriptions: *Matronis Gabiabus, ... Junonibus Gabiabus.* Every woman believed that ſhe had a female genius who protected her, and whom ſhe called her Juno. The Greeks, the Cretans in particular, and the Sicilians, rendered worſhip to the

the celeſtial bears under the name of Mothers. But it appears doubtful whether the mother goddeſſes of the Gaul's of Britain, Germany, Spain, &c. were the ſame deities. It is at leaſt certain that in conſequence of migrations, the notions reſpecting theſe goddeſſes, their functions and attributes, had at that time been ſtrangely altered. The figures given by Montfaucon hold children in their arms, like the female figures ſeen on medals of ſome of the empreſſes, with the legend *Juno Lucina*; which confirms the opinion of C. Mongez, that theſe figures repreſent the mother goddeſſes in general, and in particular the Junos and Genii of women.

PALLADIUM, OR NEW SILVER.

We have juſt been favoured with a ſpecimen of a metal, ſaid to be a new one, to which the above name has been given, and which, among others, is ſaid to poſſeſs the following properties:—1. It diſſolves in pure ſpirit of nitre, and makes a dark red ſolution. 2. Green vitriol throws it down in a ſtate of a regulus from this ſolution, as it always does gold from *aqua regia*. 3. If you evaporate the ſolution you get a red calx, that diſſolves in ſpirit of ſalt or other acids. 4. It is thrown down by quickſilver, and by all the metals but gold, platina, and ſilver. 5. Its ſpecific gravity by hammering was only 11·3; but by flatting, as much as 11·8. 6. In a common fire it tarniſhes a little, and turns blue; but comes bright again, like other noble metals, when ſtronger heated. 7. The greateſt heat of a blackſmith's fire would hardly melt it. 8 But if you touch it while hot with a ſmall bit of ſulphur, it runs as eaſily as zinc.—It is ſold only by Mr. Forſter, at No. 26, Gerrard-ſtreet, Soho, London, in ſamples of five ſhillings, half a guinea, and one guinea each.—We have not had time to ſubject the ſpecimen ſent to us to any chemical teſts. When we do, we ſhall report the reſult to our readers. Where or how it has been procured we have not yet learnt.

IMPROVED LAMPS.

Mr. Paul, of Geneva, now in London, has made ſome important improvements in the conſtruction of lamps and reflectors, by which, among other advantages, that light which is uſually thrown up into the atmoſphere and loſt, is reflected to the ſpace intended to be illuminated; by which a much greater effect is produced, and at the ſame time a ſaving in the conſumption of the oil. We underſtand they are ſoon to be employed by Mr. Smethurſt in lighting the ſtreets.

ASTRO-

ASTRONOMY.

In our last we presented our readers with tables containing the geocentric motion of the two new planets, Ceres Ferdinandea and Pallas, for the month of April; we now subjoin tables of their motion calculated for the month of May 1803.

	Geocentric Motion of Pallas.					Geocentric Motion of Ceres Ferdinandea.				
	Right Ascension.			Declin. North.		Right Ascension.			Declin. South.	
May 3	18^h	55^m	15^s	18°	38′	19^h	11^m	54^s	24°	6′
6	18	55	4	19	7	19	12	28	24	15
9	18	54	42	19	35	19	12	50	24	25
12	18	54	8	20	1	19	12	59	24	35
15	18	53	22	20	26	19	12	52	24	46
18	18	52	24	20	51	19	12	30	24	57
21	18	51	15	21	14	19	11	56	25	9
24	18	49	56	21	36	19	11	5	25	22
27	18	48	27	21	55	19	10	3	25	35
30	18	46	49	22	14	19	8	44	25	48

GALVANISM.

Professor Aldini, when on his way to France, made the following experiment at Calais:—He extended a wire from the top of the West Jetty to Fort Rouge, distant about 160 feet, and which are separated by an arm of the sea. The extremity of this wire towards the jetty was immersed in the water, the other extremity was fixed to a mast, and a portion of the wire was free. A second wire was disposed in such a manner, that its lower extremity was immersed in the water at the bottom of the mast, while its upper extremity could be made to communicate with the wire fixed to the mast. Between the extremity of the wire attached to the mast and that of the second wire immersed in the sea the professor placed an animal, as a prepared frog for example, which being then brought into contact with the two wires, immediately experienced the usual contractions. The sea water, therefore, served as a conductor between the other extremities of the wires.

A NEW SPECIES OF INOCULATION.

Accounts have been received from one of the travellers in Africa (Hornemann, we believe), stating, that in a district which he has visited he found a kind of inoculation practised, which answers the same end respecting syphilis that the vaccine pock does respecting the small-pox—exempting the patient from the possibility of infection.

LII. *Letter from* Dr. Olbers *of Bremen to* Baron Von Zach, *on the Stones which have fallen from the Heavens* *.

YOU know that in a lecture which I delivered in the Museum of Bremen in the year 1795, on the shower of stones, as it is called, which fell at Siena in Italy, I expressed the same idea which I lately read with much satisfaction in a letter of Laplace, in which he says: "It is not impossible that large masses, detached from some of the celestial bodies, and particularly from the moon, may have sometimes been projected to the earth." As you require a more circumstantial illustration of this subject, I embrace the present opportunity of gratifying your wishes.

I must readily acknowledge, that when I wrote the before-mentioned essay on the shower of stones which fell at Siena, I considered these stones to be of a volcanic origin. The stones found at Siena fell at the distance of sixty miles from Vesuvius, only eighteen hours after the commencement of the great eruption which destroyed the unfortunate Torre del Greco, and of which so elegant a description has been given by sir William Hamilton. I was acquainted with the principles of Zolner and Lichtenberg, according to which these stones could not be ascribed to Vesuvius; but to me these principles did not appear satisfactory. The great velocity which would be necessary to make a mass projected from Vesuvius to proceed to so great a distance, was not sufficient to induce me to abandon my opinion. By calculation I found that it was not so great as what might be supposed to be produced by the dreadful convulsion which takes place on such occasions. What tended chiefly to confirm me in my idea was, that sir William Hamilton then believed that he had often found at Vesuvius stones which had a great resemblance to those which fell at Siena †. I also supposed that Vesuvius might have projected from one of its mouths a half-fused mass at an angle of from forty to fifty degrees, which, like every thing else proceeding from the crater, was in a high degree electric; that this mass had

* From *Algemeene Konst en Letter-Bode*, No. 17, 1803.

† Stones of the same nature, at least as far as the eye can judge of them, are frequently found on Mount Vesuvius; and when I was on the mountain lately I searched for such stones near the new mouths; but as the soil around them has been covered with a thick bed of ashes, whatever was thrown up during the force of the eruption lies buried under those ashes, &c.—Philosophical Transactions 1795, p. 104.

taken its direction towards Siena; that when within a certain distance of the earth it had discharged itself; and that in consequence of this discharge it had burst, so that the fragments fell down in the state of ignited stones *.

On the other hand, however, it is known that no such stones are found on Mount Vesuvius. It has been lately shown by the mineralogical description of Count de Bournon, and the chemical analysis of Mr. Howard, that the stones found at Siena have a perfect resemblance to all the other stones which have been seen to fall from the heavens, and which certainly cannot be productions of our earth †. My former explanation and conjectures fall therefore to the ground, and we must class the stones of Siena among those which are formed by nature in some mode with which we are unacquainted, and which bursting always with the appearance of light fall down to the earth.

Since the time when naturalists first ventured, or were obliged, to believe in the falling of such stones, it has been found that this phænomenon is not so uncommon as was supposed. During the last century, fourteen or fifteen instances at least can be quoted.

When I erroneously ascribed in my lectures the stones found at Siena to an eruption of Vesuvius, the nature of other stones fallen from the heavens, which certainly were not of volcanic origin, had given occasion to the question, whether it was impossible that heavy masses could be projected to the earth from other heavenly bodies, and particularly from the moon? The celebrated stone which fell near Argos Potamos, in the year 462 before Christ ‡, induced me in particular to undertake an examination of this question; and on this occasion my learned friend, Mr. Bredenkamp, clergyman of Bremen, was so kind as to collect for me all the passages in antient authors which make mention of this stone. In regard to the rest, the reader may consult what Struyk, Pingré § and Chladni ‖ have said on the subject.

It appears from calculation, that when a greater vertical velocity than 34435·7 Paris feet in a second can be given to a heavy body projected from the earth's surface, supposing the atmosphere to oppose no resistance, this body would not fall

* The abbé Tata actually saw a large fire-ball thrown up from Vesuvius, which when it had reached a certain distance burst, and the abbé then heard a noise like that of stones falling down.

† Howard's Experiments and Observations on certain Stony and Metalline Substances, &c.—Philosophical Transactions 1802.

‡ Plin. Hist. Nat. lib. ii. cap. 58.

§ Cometographie, p. 256.

‖ Philosophical Magazine, vol. ii.

fall back to the earth, but would continue to move from it *in infinitum*. A cannon bullet ſometimes acquires a velocity of 1800 or 2000 feet in a ſecond *; and heavy maſſes are projected from the volcanoes of our earth with a velocity four or five times as great. This velocity, therefore, is far greater than that of 35,000 feet per ſecond. But even if it were poſſible, by the help of chemiſtry and mechanics, to give a ball a velocity of 35,000 feet, or even more, per ſecond, the ſtrong reſiſtance oppoſed by the air, which always increaſes at the leaſt as the ſquare of the velocity, would tend very much to deſtroy it. We may therefore conſider it as almoſt impoſſible that heavy bodies can ever be entirely projected from the earth. I conſider it altogether unneceſſary to take into account in this calculation the influence which the attractive force of the moon would have on the motion of a body projected in this manner.

But the caſe is entirely different if we ſubject to calculation the motion of a heavy body projected from the ſurface of the moon. The moon is a great deal ſmaller than the earth, poſſeſſes a much weaker power of attraction, and at the ſame time its atmoſphere is of ſo ſmall extent, and ſo rare, that it could oppoſe very little reſiſtance to a heavy body in a ſtate of motion. It is therefore poſſible that a heavy body might be projected from the moon with ſuch a velocity as to carry it to a diſtance where it would be attracted with greater force by the earth.

It is found by calculation that 7780 feet per ſecond is the minimum of velocity with which a body projected from the moon would require to fall upon the earth. It appears, therefore, that if heavy bodies were projected from the moon with a vertical velocity of 7800 or 8000 feet under certain circumſtances, ſome of theſe bodies would reach the earth and fall down upon it. Such a velocity appears to me to be very poſſible. The ſurface of the moon, by the new craters which ariſe, ſhows evident traces of violent eruptions, by which even as great or greater velocity might be communicated to the bodies thrown up by them.

It appears then, that it is not altogether impoſſible that the ſtones or maſſes which have been ſeen to fall from the heavens, and which, though entirely different from all the mineral bodies of our earth, have a great reſemblance to each other, may have fallen from the moon. It is in their great ſimilarity and correſpondence that the grounds of this opinion are to be found; for the ſimilarity of their external appear-

* Mém. de l'Acad. Royale des Sciences 1769, p. 247.

ance, and of their component parts, evidently ſhow that they have all had the ſame origin. If we admit, with Halley and Chladni, that, beſides the large celeſtial bodies, there are in boundleſs ſpace an infinite number of ſmall maſſes which move about till they approach ſo near a planet as to enter its atmoſphere, when they take fire, burſt, and fall down upon it; we can explain why all theſe maſſes diſperſed throughout infinite ſpace conſiſt of iron, nickel, ſiliceous earth, and talc earth, which, according to the ingenious experiments of Mr. Howard, are the component parts of all the maſſes which have fallen from the heavens.

But, on the other hand, great difficulties occur, if theſe ſtones which have fallen from the heavens be ſeriouſly conſidered as bodies projected from the moon. In conſequence of the motion of the moon, bodies projected from it acquire, beſides their projectile velocity, that velocity which the moon has in the direction of the tangents to her orbit. If we therefore take this velocity into the account, it will appear, that heavy bodies projected from the moon with a velocity of 8000 feet or more per ſecond, as ſoon as they have got to ſuch a diſtance from the moon as to experience leſs attraction from it than from the earth, would deſcribe around the earth a conic ſection paſſing more or leſs through the moon. Theſe conic ſections, according to the difference of the direction and velocity, may be either hyperbolas or ellipſes *. In order that the body ſhould fall to the earth, the ellipſe it deſcribes ought to be of ſuch a nature that its perigeum falls within the body of the earth, or at leaſt within its atmoſphere. The moon, therefore, muſt perceptibly decreaſe in ſize, as it would be neceſſary that it ſhould throw out a great number of maſſes to make ſome of them reach the earth. For this purpoſe alſo a very limited direction and velocity of the heavy bodies would be required. And would not an infinite number of ſuch ſmall fragments move around our earth as ſatellites? Would they not be viſible through our beſt teleſcopes, as we know that fire-balls ſometimes are of very great ſize, and as the obſervation of Ceres and Pallas has ſhown that bodies of a very ſmall diameter become viſible to us when illuminated by the light of the ſun; or are the ſhooting ſtars, which ſeem to have a coſmical origin, ſuch ſmall ſatellites of our earth? Perhaps we ought to claſs among theſe alſo the ſmall pale luminous ſpot which Schröeter ſaw paſs over the field of his teleſcope. Theſe objections, and others which

* A prodigious velocity would be required to make a body projected from the moon to fall to the earth in an hyperbola.

arife

arife from an examination of the circumftances of their falling, feem to me to be of great importance, and difficult to be removed.

I am therefore far from afferting that thefe ftones which have fallen to the earth are to be confidered as maffes projected from the moon; nor does Laplace make any fuch affertion. His object, as well as mine, is to fhow philofophers engaged in refearches on this fubject the poffibility of thefe maffes having a *felenitic* origin. It is much to be wifhed that the ingenious Chladni would favour us with a new edition of his celebrated effay on the mafs of iron found in Siberia *, as he no doubt would be able, from Benzenberg and Brandes' Obfervations on falling Stars, Howard's Chemical Examination, and from various other documents, to make confiderable additions to it.

LIII. *On the Nervous Power, and its Mode of acting* †.

IT has been generally fuppofed by phyfiologifts that the power by which fenfations were tranfmitted to the fenforium, was likewife the medium by which mental impreffions were communicated to the body. But this opinion is totally inconfiftent with that moft frequent obfervation, that very often every poffible fufceptibility of fenfation is loft in a whole limb, which neverthelefs retains voluntary motion. This appears moft ftrikingly in the St. Vitus's dance, which deprives the afflicted parts of every fufceptibility of fenfation without deftroying voluntary motion. And, on the contrary, there are cafes where the functions of the fenfes remain unimpaired, and are fometimes increafed, while the mufcular motion is completely loft. In order to explain this phænomenon two kinds of nerves have been hypothetically adopted, nerves of fenfation and nerves of motion; but without rendering the explanation more fatisfactory. Certain it is, that the action of mental irritation upon the body, and the communication of the fenfations with the fenforium, are effects of two different powers, which cannot poffibly have their feats in one and the fame organ.

That which is underftood by the word *nerves* confifts properly of two entirely different parts, the *medullary fubftance*

* Uber den urfprung der von Pallas gefundenen und anderer ihr ähnlicher Eifen maffen, und über einige damit in verbindung ftehende Natur-erfcheinungen; Von E. F. F. Chladni. Riga 1794. 4to.

† From *Reil's Archiv für die Phyfiologie*, vol. i.

of the nerves, and the *cellular texture*; the latter being composed of cylindric tubes, containing the former in their cavity: and in these tubes, these sheaths of the nerves, is the seat of the power which continues the irritation of the mind into the body. The medullary substance of the nerves, on the other hand, possesses no other power than that of exciting in the sensorium sensations corresponding with the impressions received by the senses. The cellular texture of the nerves possesses a power of contraction, elasticity; but the medullary substance of the nerves possesses only the simple sensitive power of the nerves. From this, the above-mentioned phænomena, especially those observable in St. Vitus's dance, are easily explained. The sensitive power of the nerves disappears, because its organ, the medullary substance, is destroyed or wounded. The two following arguments confirm the correctness of this opinion:—1. According to Aaneman's numerous experiments on the regeneration of the nerves, each end of a nerve which has been cut in two forms itself into a scirrhus, and both afterwards join again in the cellular texture; but the lower end of the nerve thus intersected always loses its sensitive power, whereas it recovers in a few months the power of motion when both the ends are joined again by a sufficient quantity of the cellular substance. 2. Arsenic and all sorts of mercurial preparations, when immediately applied to the brain, exhibit not the least immediate effect upon it. But those very minerals, when applied in any other part, excite the most violent convulsions of the whole body; and it is well known, from other circumstances, that these produce the greatest irritation upon the cellular texture. Without entering into any further elucidation, every one will easily conceive the great importance of these ideas in the explanation of many physiological and pathological phænomena.

LIV. *Letter from Dr.* Barton *to Professor* Zimmermann, *on the fascinating Faculty which has been ascribed to the Rattlesnake, and other American Serpents.*

[Concluded from p. 202.]

AFTER quoting Mr. Michaëlis's observations, which I have already noticed, Mr. Blumenbach has the following words:—"I would, however, add another mode of explanation from Dr. Barton's work itself, where he assures us that the result of his inquiries, whether the rattlesnake creeps up trees

trees or not, induces him to believe the latter to be the case. The rattlesnake," Mr. Blumenbach continues, "is also one of the laziest of all the serpent tribe; under these circumstances it seems very natural that such a lazy animal should be endowed with the fascinating power of bringing down from trees small animals, which otherwise would have nothing to fear from a snake that cannot creep upwards."

It is true, as I have asserted, that the rattlesnake is one of the most sluggish species of serpents; and further inquiries have confirmed me in my former opinion, that this serpent does not climb up trees. But if Mr. Blumenbach had recollected what I have so particularly said on the subject of the nidification of our birds *, he would not, I presume, have imagined that it is at all necessary that the serpent should be endowed with "a fascinating power of bringing down from trees small animals." I have shown that the rattlesnake feeds upon bull-frogs, which are never found upon trees; upon the ground-squirrel, which is most commonly found upon the ground; and upon the fringilla erythrophthalma, or ground-robin, a species of finch, which receives its common English name from its being so generally seen upon the ground †. I may now add, that this reptile feeds upon young rabbits (lepus americanus), wild mice of different kinds, moles (sorex aquaticus), and many other small animals, which it cannot have much trouble in obtaining without its possessing the power of charming.

But although the rattlesnake is, in reality, a sluggish reptile, it is nevertheless an animal of more activity than Mr. Blumenbach seems to imagine. I believe it is true, as the old Indian ‡ informed Mr. Heckewelder, that in the spring season these reptiles make considerable journeys from their dens in search of food. I know it to be a fact, that they swim across streams of water, and even over large rivers. It is observed by the hunters and others, that the rattlesnake swims faster than it moves on the land. Indeed, it seems to run upon the surface of the water. It is very probable that in these watery peregrinations it may occasionally have opportunities of catching certain kinds of fish. But this is a mere conjecture, which at present I am incapable of supporting by any decided fact.

I have observed in my memoir, that "among the Indians of South America I do not find any traces of the notion that serpents can fascinate other animals." Mr. Blumenbach,

* A Memoir, &c. pages 50, 51, 52, 53. † Ibid. pages 63 and 64.
‡ See page 31.

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however, informs us, that Dobrishoffer asserts, in his History of the Abipons, "that all the Spaniards and Indians in that part of Paraguay unanimously ascribe a like property to the snake called *ampalabas*." I also find that Dr. Bancroft has mentioned the fascinating power of a large but innocuous species of serpent which inhabits Guiana *.

I was ignorant of these facts when I printed my memoir; and now that they are known to me, they do not appear to be of much consequence. They certainly do not prove that serpents are endowed with the power of fascinating. It is not by any means ascertained that the Abipons have not derived the notion from the Europeans, with whom they have been long acquainted.

Since the publication of my memoir I have been able to make a more complete collection of the sentiments of the North American Indians on the subject. I am led to believe, that it is far from being the general opinion among these people that the rattlesnake is endowed with the faculty of charming. I cannot in any other way so strikingly show the notions of the Indians on the subject, as by extracting part of a very curious manuscript which I received from my friend Mr. John Heckewelder:—"Having questioned Indians a number of times with respect to snakes having the power of charming, and always being answered in the negative, I was at length desired," says Mr. Heckewelder, "to give the reason the white people had for believing such a thing; which not being satisfactory, Pemaholend † declared: 'The rattlesnake obtains its food merely by slyness, and a persevering patience. It knoweth as well where to watch for its prey as a cat does, and succeeds as well. It has, and retains, its hunting grounds. In spring, when the warm weather sets in, and the woods seem alive with the smaller animals, it leaves its den. It will cross a river and go a mile and further from its den to the place it intends to spend the summer; and in fall, when all the young animals bred this season are become strong and active, so that they are no more so easily overtaken or caught, it directs its course back again, to its den, the same as a hunter does to his camp.

"'The white people,' continued Pemaholend, 'probably have taken the idea of this snake having the power of charming from a tradition of ours (the Indians), which our forefathers have handed down to us, from many hundred years

* An Essay on the Natural History of Guiana, &c. p. 205: London 1769 Mr. Stedman, a late writer, positively denies the existence of this fascinating power in the aboma, the serpent mentioned by Dr. Bancroft.

† An aged and much respected Delaware Indian.

5 back,

back, and long before ever the white people came into this country. Then (they tell us) there *was* such a snake, and a rattlesnake too; but then there was only *this one* snake which had this power, and he was afterwards destroyed; and since that time it hath never been said that any other of the kind had made its appearance.'"

The whole of this tradition, as related by Pemaholend, is in my possession. It is a very curious piece of American mythology, and will be published at large in another place, perhaps in my Fragments of the Natural History of Pennsylvania. It is a new proof of my assertion, "that the mythology, or superstitious religion, of the Americans is a fragment of that mythology whose range in Asia and in Africa has been so extensive *." But this tradition is interesting in the discussion of the question in which I am now engaged. It plainly shows that the Indians do not in general suppose that the rattlesnake is gifted with the faculty of charming; and it renders it still more doubtful that the whites derived this notion from the Indians.

The Indians are so far from believing in the existence of this faculty in snakes, that the worthy gentleman from whom I received the tradition which I have just mentioned, assures me that he would be unwilling in future to trouble them with any further inquiries on the subject, as the sure reward of the pains of inquiring is a laugh at the easy credulity of the Whites. I may here add, what I have mentioned in my memoir, that Mr. William Bartram never understood that the nations of Indians among whom he travelled had any idea of the fascinating power of snakes †. Among other Indians Mr. Bartram visited, with the zeal and knowledge of a naturalist, the nations of East and West Florida. As this ingenious and amiable gentleman believes that serpents can charm other animals, there will be no suspicion, among candid people, that he has concealed the opinions of the Indians on the subject.

I think I have now considered every essential part of Mr. Blumenbach's remarks on my memoir. I have little doubt that this illustrious professor, who is not less candid than he is learned and ingenious, will give to the new facts which I have adduced all the consideration which they merit. What is the proportion of that consideration I must leave it with you and other able judges to decide. In the meanwhile I am not a little flattered that one of my earliest essays in natural history has solicited so much of the attention of the philosophers of Europe.

* A Memoir, &c. p. 16—Note. † Ibid. p. 14.

You

You inform me, that my explanation of the supposed fascinating faculty of serpents is adopted by many of your naturalists. This is pleasing to me. Indeed, such is our selfishness, that I fear I should have felt somewhat gratified to learn that the theory had been adopted, though I myself had relinquished it. But I assure you that, as yet, I have seen no cause to relinquish it. On the contrary, I possess a great body of additional facts in support of it. These facts will be carefully adduced in that part of my Fragments which is intended to comprise the history of the *amphibia* of Pennsylvania.

In my native country the explanation which I have offered has been adopted by many persons. But there are others who still believe in the existence of a true fascinating faculty in the rattlesnake and other serpents. What change time and further attention to the subject may accomplish in them, I know not. But why should we expect to make all philosophers converts to our opinions? Almost every phænomenon, almost every fact in nature, seems to admit of an explanation upon more than one principle. The stream of inquiry is often diverted by trifling circumstances into very opposite directions. Prejudices, or, to name them by a milder phrase, the earlier biasses of our minds, frequently detain us, in the investigations of science, in a long and pleasing reign of tyranny. Our first love is said to be the strongest. Our first principles in science, in religion, and in politics, are often adhered to with the extreme of pertinacity. He who, turned of fifty years of age, relinquishes a favourite error, has infinitely more merit than the world may be willing to allow him.

I beg you, sir, to make what use of this letter you may think proper. If it shall add any thing to the stock of your knowledge on the subject, or if it shall serve to amuse you in an hour of leisure, I shall feel highly gratified.

Be assured that I am, with very great respect,
Dear sir, your faithful and obliged
servant and friend,
BENJAMIN SMITH BARTON.

POSTSCRIPT.

I BEGAN this long letter on the very day that I first saw Mr. Blumenbach's remarks in Tilloch's Magazine. I had not finished it before I received a copy of the original publication of the professor. In the conclusion I find he urges me to extend my inquiries into the real use of the *crepitaculum caudæ*, or rattle of the crotalus. This is certainly a question worthy

worthy of the attention of American naturalifts, who enjoy the beft opportunities of inveftigating the fubject. I am, indeed, inclined to think that we are not yet acquainted with the real or exclufive ufe of the rattle of the crotalus. That it was given to this reptile to warn man and other animals of a dangerous enemy, does not appear a fufficient explanation of the ufe of the organ. Many ferpents whofe poifon is not lefs deleterious than that of the rattlefnake, are entirely deftitute of any apparatus like the crepitaculum of this reptile. Befides, we have feen that, when moft intent upon obtaining his prey, the rattlefnake keeps his rattle ftill. This would feem to fhow that it was not defigned to terrify its enemies. Indeed, it is highly probable that one reafon why the rattlefnake fo frequently fucceeds in capturing animals is, becaufe he makes no noife, and therefore furprifes his prey.

I do not doubt that the crepitaculum of the rattlefnake is an organ of very effential importance: but I muft fay that it has always been deemed of more importance than it can yet be fhown to be. Thus it has been faid to give an unerring indication of the age of the reptile. In this refpect it is a lefs fure criterion than has been generally imagined. It is a fact which, I believe, has entirely efcaped the notice of all the writers on the natural hiftory of this reptile, that the rattles are formed before the exclufion of the young ones from the uterus. Towards the latter end of Auguft a number of female rattlefnakes were opened. The young animals were about five inches long, and about the thicknefs of a fmall-fized goofe-quill: the fcales were formed fo as to be vifible to the naked eye; the head very large, and the fangs, though of a fomewhat gelatinous confiftence, were fhaped, and diftinctly vifible. The rattles were fo far formed that three bells could be plainly difcerned; and this was the cafe in more than fixty inftances. Hence it is evident, that when they are excluded from the womb the young animals have at leaft three rattles. After this, I believe, they generally acquire two bells every year. Yet, in one inftance, a rattlefnake * has been known to acquire four bells in the term of a year. I may add, that the bells are liable to be loft: they are fometimes broken, and it is not improbable that they wear out.

I am fometimes almoft inclined to think, with your learned and eloquent countryman Mr. Herder, that "natural hiftory has reaped no advantage from the philofophy of final caufes." And yet without an inquiry into the ultimate intentions of nature, what is natural hiftory? A barren wafte

* In the Mufeum of Mr. Peale.

of

of unconnected facts. Speculations, which too often, indeed, proceed from indolent philosophers, are necessary to render natural history an agreeable and even useful science. We are, moreover, sometimes able to discover the final cause or intention of nature in her operations. And as to the *usus partium*, every philosopher must confess that this is a question which ought never to be neglected. It is a kind of soul to the science of anatomy. It is exceedingly to be regretted, however, that we are so often at a loss to determine the uses of parts even where the forms and structure of these parts are well known to us.—But let us not despair. Nature intends to reveal to us many things (precious in their kind), which are now entirely unknown to us. Physiology will, in time, assume one of the highest stations in the range of sure as well as splendid sciences.

LV. *A Survey and Report of the Coasts and Central Highlands of Scotland; made by the Command of the Right Honourable the Lords Commissioners of his Majesty's Treasury in the Autumn of* 1802. *By* THOMAS TELFORD, *Civil Engineer, Edinburgh, F. R. S.*

MY LORDS,

IN reporting upon the survey I made in Scotland, in obedience to the instructions I had the honour of receiving from your lordships, dated the 1st of July 1802, I find the business may be most conveniently arranged under the following heads:

I. What regards rendering the intercourse of the country more perfect, by means of bridges and roads.

II. Ascertaining various circumstances relative to the Caledonian canal, especially with regard to the supplies of water on the summit level, and the best communications from this canal to the fishing locks at the back of the Isle of Skye.

III. The means of promoting the fisheries on the east and west coasts.

IV. The causes of emigration, and the means of preventing it.

V. Improving the means of intercourse between Great Britain and the northern parts of Ireland; particularly as to the bridges and roads between Carlisle and Port Patrick, and also the harbour of Port Patrick.

Under each of those heads are comprehended subjects highly deserving the attention of government; the more they

they are investigated, the more important they will appear, and the public will become more fully convinced, that the general interests of the British empire are extensively connected with the several improvements which are mentioned in your lordships' instructions.

Of Bridges and Roads.

The obstacles which at present obstruct the communications in the north of Scotland are numerous and well known, not only to the inhabitants, but to every person who has travelled through, or even inquired into the state of, the country.

Previous to the year 1742, the roads were merely the tracks of black cattle and horses, intersected by numerous rapid streams, which being frequently swoln into torrents by heavy rains, rendered them dangerous or impassable. The military roads, which were formed about this time, having been laid out with other views than promoting commerce and industry, are generally in such directions, and so inconveniently steep as to be nearly unfit for the purposes of civil life; and in those parts where they are tolerably accessible, or where roads have since been formed by the inhabitants, the use of them is very much circumscribed from the want of bridges over some of the principal rivers.

The general connections of the country may be stated as leading from Edinburgh to the north and north-west counties, by means of one road through the Highlands, and by another along the east coast and south shore of the Murray Frith to the town of Inverness, and from thence through Beauley and Dingwall, to Tain in Ross-shire. From Glasgow and Greenock, the communications by land are through Argyleshire, to the western parts of Inverness and Ross-shire, and to the shores opposite the whole of the Hebrides. There is an important communication from Inverness westward, across the country to Fort Augustus and Fort William, and from Fort Augustus there are just the vestiges remaining of what was once a military road to Bernera, opposite the back of the Isle of Skye.

In considering these lines of roads, it appears most regular to begin on the borders of the improved country, and near to the seats of commerce and industry. In proceeding from Edinburgh northwards, by the east coast and Moray Frith to Inverness, or through the central Highlands to the same place, and from thence to Tain on the Dornoch Frith in Ross-shire, we find the communications intercepted, and we learn that accidents frequently happen from the want of a

bridge

bridge over the river Tay, at Dunkeld, in Perthshire; another over the river Spey, at Fochabers, in Bamffshire; a third over the river Beauley, in Inverness-shire; and a fourth over the river Conon, near Dingwall, in Ross-shire. These rivers are large, and at present are all crossed by means of ferry-boats.

At Dunkeld the river Tay is deep and broad, and there is reason to expect the foundations will be expensive, the bed of the river at and for a great distance above and below the town being composed of alluvial earth and gravel. The best situation for a bridge is a little below the lower ferry; at this place there is a straight reach of the river, and in winter the ice is broken by passing over a ford nearly opposite the mouth of the river Bran. This situation will also connect with the improved lines of road which are proposed to be made on each side of the river. It is probable that a flat rubble stone will be got near the slate quarries, which are within a short distance of the place. Freestone of a durable quality is to be had near Dundee: it may be brought by water carriage to Perth, and from thence by land to Dunkeld.

Under all these circumstances the expense would be considerable; and, taking into account the uncertainty of the foundations, the amount cannot be stated at less than 15,000 l.

The two ferries which are now at Dunkeld belong to his grace the duke of Athol; he has authorized me to state, that if government will defray one-half the expense of a bridge, he will advance the other half; that he will give up his interest in the ferries, if in lieu thereof a reasonable toll be put upon the bridge, in order to liquidate the capital advanced by the duke: after this has been accomplished, with a small surplus to answer the repairs, the bridge ever after to remain free of toll.

This seems a very reasonable and just mode of defraying the expense: the safety and accommodation would be so great, that no person travelling that road could object to paying the same toll for a safe and convenient bridge which at present is paid for a dangerous and inconvenient ferry-boat, especially when there will be a certain prospect of having a bridge free of toll in a few years.

This bridge is of the first importance to the Central Highlands; it would accommodate a great district of that country, and at the same time facilitate the communication with the North Highlands.

The river Spey is also rapid and deep, being the drain of a great extent of mountainous country, where there is much rain.

rain. It is of courſe a very dangerous ferry. This ferry is on the great coaſt road eaſtward from Inverneſs and Fort George, through the towns and cultivated country in Murray and Banff-ſhires, from whence it paſſes through Fraſerburgh and Peterhead to Aberdeen.

Another branch of road alſo ſtrikes off at Fochabers, on the Spey, and paſſes by Huntly and Inverury to Aberdeen.

The neceſſity of having a bridge over the Spey at this place became ſo urgent, that his grace the duke of Gordon began a ſubſcription in the adjacent country in order to raiſe a part of the money neceſſary to defray the expenſe of a bridge; his grace ſet a liberal example, and it has been followed by moſt of the gentlemen in that part of the country. In conſequence of this exertion, a contract has been entered into, and ſome ſteps have been taken towards carrying this uſeful work into execution; but unleſs government will grant an aid equal to one-half the expenſe, the works muſt ſtill be left unfiniſhed, and unfit for the purpoſes intended.

The ſituation fixed upon for this bridge is adjacent to the ferry and town of Fochabers. At this place a rock paſſes quite through the river, at about from eight to ten feet below the ſurface of ordinary low water; and, as far as I could learn, it is the only place, unleſs at a great diſtance up the country, where the rock paſſes quite through the river. On theſe accounts it was judicious to prefer it for the ſituation of the bridge; and it was fortunate this happened preciſely in the line of the preſent road.

As one-half of the expenſe will be raiſed by ſubſcription in the neighbourhood, if government will defray the other half, I underſtand it is propoſed that the bridge ſhall be free of toll. The expenſe cannot be ſtated at leſs than 12,000 l.

I have made plans and ſections for both thoſe bridges. On account of their being ſo nearly connected with the ſeats of the two before-mentioned noblemen, I have introduced more decorations than what are abſolutely neceſſary for common road bridges. This extra expenſe will not amount to much; but whatever it is, I propoſe it ſhall be defrayed by thoſe noblemen.

I laſt year produced plans and eſtimates for the bridges over the rivers Beauley and Conon: I have again examined the propoſed ſituations, and perceive that, on account of the uncertainty of the foundations, and the alteration which muſt be made in ſome parts of the beds of the rivers, it will be neceſſary to take the expenſes of each bridge at 5000l. inſtead of 4000l.

Theſe two bridges are greatly wanted, in order to facilitate the

the communications with Ross-shire, Sutherland, and Caithness; they are equally so for the north-west coast of the main land, and the northern parts of the Hebrides; they are the roots from which a great number of branches of roads are to proceed, which are necessary for the improvement of the country and the extension of the fisheries.

Before entering upon the consideration of the roads to the north of the line of the Caledonian canal, it is necessary to speak of the communications from Glasgow and Greenock by Argyleshire to Fort William. From Glasgow there is already a road, which passes through Dumbarton up the west side of Loch Lomond, by the upper ends of Loch Long and Loch Fyne to Inverary. From Greenock, by crossing the frith of the Clyde, there is a road which passes up the east side of Gare Loch and Loch Long, and joins the road to Inverary at the top of Loch Long. From Inverary there is one road which passes the upper end of Loch Awe, and another which crosses that loch by a ferry at Port Sonachan; and these roads unite at Bunawe, on the banks of Loch Etive. From Bunawe the road is already made to Oban, and a branch crosses Loch Etive and passes along the south side of the Linnhe Loch and Loch Eil to Fort William. Between Bunawe and Fort William there are three ferries, over arms of the sea, which running many miles into the land, cannot well be avoided: in other respects, the communication from Glasgow and Grenock, thus far, is tolerably good. The Highland Society, in the excellent report to which I shall frequently have occasion to refer, and which may be found in the appendix*, have pointed out a new line of road from the north side of the Frith of Clyde, nearly opposite to Greenock, to be carried to the Bay of Strachan upon Loch Fyne: this would be a very direct line from Greenock to Inverary, but it would be subject to two ferries, and it seems doubtful whether this inconvenience would not overbalance the additional distance round the upper end of the lochs; at least, as there is already a very good communication by this road, it seems most prudent to attend to the other more necessary portions of road before this is undertaken.

From Fort William it will be very adviseable to improve and extend the road which passes along the north side of the portion of Loch Eil which turns from Fort William to the west, and to carry it from thence across the upper end of Loch Shiel, through Arrasaig to Morer, as described in the

* This shall appear in our next Number.

report

report of the Highland Society. This would open a very direct communication from the Clyde to the fishing lochs at the back of Skye, to Skye itself, and to the islands of Egg, Rum, Muck, Barra, and South Uist. This would prove of great importance to the fisheries on account of facilitating intelligence, which is one of the most necessary steps to promote the success of this business.

In the year 1796, Mr. Brown, of Elgin, made a survey and estimate of this road from Fort William to Morer, and stated the expense at 6456 l.; since that time I understand that about 1500 l. has been laid out upon it, so that 4000 l., and perhaps somewhat more, is still required to render it perfect.

With regard to the improvement of the roads which lead from Fort William east to Inverness, there is one principle which in future ought never to be lost sight of, which is, to make the new roads as near to the banks of the rivers and lochs as is practicable at a reasonable expense. If the Caledonian canal is executed, it is more than probable that many improvements will be pointed out in the course of carrying on that great work; and it would be imprudent to decide rashly in a matter which is so much connected with this national object.

We now come to consider the communications of the countries which lie to the north and west of the track of the Caledonian canal. From this valley, which runs from Fort William to Inverness, it is of great importance that there should be lines of communication with the Isle of Skye and the fishing lochs which lie at the back of it; these lines of road are not only necessary for promoting the fisheries, but are urgently called for by the situation of the interior parts of the country, where there are many fertile valleys which hitherto have remained nearly inaccessible: it is incalculable the loss which the public has sustained, and are about to suffer, from the want of roads in this country.

From the bridges of Beauley and Conon, lines of road, from the same important causes, are wanted in several directions to the west coast, and through the whole of the counties of Ross-shire, Sutherland, and Caithness. The outlines of those roads are well described in the report of the Highland Society; and although there is a diversity of opinion as to the comparative importance of some of them, as well as of those to Skye, yet it is evident that they are all necessary for the welfare of the country.

The empire at large being deeply interested in those improvements, as it regards promoting the fisheries and in-

creasing the revenue and population of the kingdom, justifies government in granting aid towards making roads and bridges in a country which must otherwise remain, perhaps for ages to come, thus imperfectly connected. Yet as the land-owners in those extensive districts through which the roads would pass, and indeed the whole of the adjoining districts of country, would enjoy improved cultivation and pasturage, increased incomes, and all the blessings which are to be derived from a facility of intercourse, it is certainly just that they should contribute a share with government in the expense of acquiring those advantages. They might be enabled to do this without inconvenience to the present possessors, by being empowered by an act of parliament to sell land, or borrow money upon the land, to the amount of their proportion of the expense to be incurred by the roads and bridges. This is reasonable, because the money so raised would be applied to improve the remainder of the entailed estate, which would be enhanced in value though somewhat diminished in extent.

The expense of the lines of road which were surveyed and estimated by Mr. Brown, comprehending the whole of the beforementioned counties, and nearly 1000 miles in length, did not amount to 150,000l. If, therefore, we admit an equal quantity of lines of road, to be undertaken and completed in the course of three years, would require an annual supply of 50,000l.; and supposing this to be raised in equal moieties by government and the land-owners, it would amount to 25,000l. each: but as it is not likely the whole could be brought so immediately into operation, it may, with more probability, be expected that six years would be taken up in executing all the lines, which would reduce the annual supply to 25,000l. or 12,500l. from each party. But this is exclusive of the four great bridges, the total expense of which is reckoned at 37,000l.; if they were undertaken by proper persons they might be executed in three years, which would require an annual supply of 12,333l. 6s. 8d.; and if government was to grant one-half,

It would be annually -	£. 6,166	13	4
To which add the former	12,500	0	0
	£. 18,666	13	4

Speaking therefore generally, if government was disposed to encourage these plans of improvement, and would agree to advance 20,000l. in each of the first three years, and 12,000l. in each of the last three years, it would then remain with the land-owners of the districts of country through which the lines

lines were to be carried, to come forward with their surveys and estimates, and subscriptions to one-half the amount of the expense, proving at the same time, to the satisfaction of government, that the proposed lines would be of public as well as private utility. It would be necessary also to provide that the works should be substantially executed, and that the land-owners or others interested should always lay out a certain sum before government advanced an equal moiety.

Means should be provided for the maintenance of the roads and bridges after they have been completed; and for this purpose there should either be a fund reserved, or a small toll laid on, to go in aid of the statute labour of the country. A very important consideration also, is the erecting and maintaining proper inns upon the roads.

Several of the houses which were built by government upon the military roads, are striking instances of the necessity there is of giving the people who are to keep the inns something else to depend upon besides what arises from supplying travellers; there should be some land attached to the house, at a rent to be settled by reference. I am not prepared to say what the quantity should be, or of what particular description; it is at present sufficient to point out the principle.

Upon the whole, as far as regards the bridges and roads, I can have no hesitation in stating, that they are of the greatest moment for promoting the improvement of the country, and for perfecting the connections with the fishing lochs and the Hebrides; and I shall hereafter endeavour to explain my reason for thinking that some share of the emigrations is to be attributed to the want of proper communications.

Naval Stations.

Before entering upon the subject of the Caledonian canal it will be proper to observe, that I again examined the Bay of Cromarty, and have procured some more information respecting it and the Murray Frith.

Mr. Henderson, the resident custom-house officer, a man of respectability, has, at my desire, ascertained the depth of water in the wells, and also what quantity flows from a spring about half a mile from the town. From this letter it appears, that at the depth of twenty feet from the surface of the plain upon which the town stands, there are four feet of water in their wells; when at Cromarty I learned, that at high springs this water is brackish, but it is generally used for washing, and other domestic purposes. At the distance of about half a mile from the town there is a fine spring, which was discovered by the late Mr. Ross during his ineffectual attempt

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to find coal: from this circumſtance it is called the Coal Well. This ſpring produces, on an average, upwards of twenty hogſheads of water in an hour; this water might be collected into a reſervoir at a ſmall expenſe; from this reſervoir it might be brought to the ſhore, which is a ſhort diſtance, in pipes, and by means of hoſe run into caſks in a ſhip's boat: to protect the boats, a ſmall pier might be formed at this place.

Captain Duff, of the royal navy, who is well acquainted with the country, and has navigated the Moray Frith in a frigate, has been ſo obliging as to reſolve ſome queries which I took the liberty of tranſmitting to him through his brother-in-law colonel Dirom. Captain Duff confirms the general report of the excellence of the Bay of Cromarty, and the entrance to it; his opinion reſpecting the navigation of the Moray Frith is quite as favourable as I have been led to advance in my laſt report. From what he ſtates it appears, that even with a contrary wind a ſhip of war could clear the headlands in forty-eight hours from the time of leaving the Bay of Cromarty. From this account, perſons converſant in naval affairs will be able to judge how far this bay would be ſuitable for a ſquadron deſtined to watch the mouth of the Baltic and protect the coaſt. It would be ſingularly well ſituated for convoys to veſſels coming from the weſtward through the Caledonian canal, and when returning with the ſame trade; after ſeeing the merchant ſhips paſs Fort George, the ſhips of war would be cloſe in with their own harbour.

As an aid to this ſtation, the harbour of Aberdeen might be made to receive frigates. This harbour is not embayed, and frigates might ſail from it at all times. In my laſt report I ſtated the expenſe which would attend improving this harbour, and I diſtinguiſhed what extra expenſe would be required to render it capable of receiving frigates, which appeared to be 33,700 l.

The magiſtrates of the town, by whoſe ſpirited exertions ſeveral valuable improvements have already been effected, have authorized me to ſay, that they are ready to co-operate with government as far as their circumſtances will admit. If frigates were ſtationed at Aberdeen, and large ſhips at Cromarty, a naval protection would be immediately obtained in that quarter at a very moderate expenſe; and experience would point out what future improvements were neceſſary upon this coaſt.

From Aberdeen, Peterhead, and Fraſerburgh, a communication might be kept up with Cromarty by means of ſignals or a telegraph, or by land expreſſes to Nairn, where

the

the frith is only three leagues over; or a faſt failing veſſel would ſoon run with an eaſterly wind from Fraſerburgh to Cromarty.

If Cromarty Bay was made a roadſtead, there would be wanted a ſtorehouſe and ſome other conveniencies, which may be on a ſmall ſcale, until the merits of the place have been fully proved: allow an expenſe here of 5000l.

The Caledonian Canal.

I paſſed along the whole line of this canal, that is, from Inverneſs on the eaſt, to Fort William on the weſt coaſt. I took much pains to examine into the nature of the navigation of the lochs, their ſoundings, and anchoring places. For this purpoſe I applied chiefly to Mr. Guynn, who commanded the Lochneſs galley, in government ſervice, thirty-ſix years; from him I obtained a very full and ſatisfactory account of Lochneſs: he alſo took the ſoundings of Loch Oich and a part of Loch Lochy for me.

From him I learnt that Lochneſs is twenty-two miles in length, and from one to two and a half miles in breadth; that its extreme depth is 135 fathoms, and generally 15 to 20 very near the ſhores; that there are ſix anchoring places on the north, and four on the ſouth ſide; and that at each end of the loch there is a good anchorage in from three to five, eight, and ten fathom water.

That a veſſel paſſing from the weſt to the eaſt end before a weſterly wind, or in a contrary direction before an eaſterly wind, has nothing to do but run before the wind the whole way, which ſhe would do in from three to five hours, and with contrary winds in moderate weather ſhe would work it in from twenty-four to thirty-ſix hours.

That the eaſterly winds generally prevail from March till the end of September, when the weſterly winds ſet in, and continue for the reſt of the year.

The ſoundings he took in Loch Lochy are from ſeven to ſixty-eight fathoms, with bold ſhores and good anchorage.

In Loch Quoich, which is a ſhort loch on the ſummit level, there are ſome ſhallow parts, but they may be made ſufficiently deep.

I next proceeded to examine the ſupplies of water which are on the ſummit level, and for this purpoſe I paſſed up the valley of Glengarey to Loch Hourn at the back of Skye. In this valley I found Loch Garry, which appears to be upwards of five miles in length, and from half a mile to one mile in breadth: towards the head of the valley is Loch Quoich, which appears to be upwards of eight miles in length, and

 from

from one to two miles in breadth: these natural reservoirs, placed in an extensive valley and a rainy country, form an abundant provision for every purpose to which water can be applied in the course of the canal.

Having ascertained these points, I passed by a very rocky and precipitous tract down to the head of Loch Hourn; from Loch Hourn I travelled by a tract scarcely less rugged to the top of Glen Elg, and over the steep mountain of Raatachan to the top of Loch Duich; from thence I travelled along the vestiges of a military road, up Glen Shiel, down a part of Glen Morrison, and over a rugged mountain to Fort Augustus. In Glen Morrison and Glen Garry it is possible to make roads, if judiciously laid out, upon an easy ascent; but the idea of water conveyance through them between the Caledonian canal and the fishing lochs is altogether unadvisable.

My next object was to examine the country which lies between the top of Loch Eil and Loch Shiel, in order to find whether a water conveyance could be made at a moderate expense from Loch Eil through Loch Shiel, and so into the fishing grounds to the south of Skye, without passing down the Linnhe Loch, up the Sound of Mull, and round the Point of Ardnamurchan. I carried a level across the neck of land which separates Loch Eil from Loch Shiel: the distance is about three miles. I found the summit of the land forty-three feet above high water in Loch Eil, and thirty-five feet five inches above the level of the fresh water in Loch Shiel. In order to form a canal, as there is no water to be got on this summit, the ground must be cut down to twelve feet below the level of the water in Loch Shiel, which would make forty-seven feet five inches of cutting, and this depth of cutting would be continued for nearly a mile: I also suspect that in this distance rock would be met with. I am therefore sorry to say, I cannot advise the work being undertaken before the nature of the ground has been fully proved, and the whole of Loch Shiel has been examined with great care: and as this passage cannot be useful unless the Caledonian canal be made and navigated from the east, if that event should take place, there will be plenty of time to re-examine this point with care; at present it ought, in my opinion, to be postponed.

Having investigated all the points which fell under my observation as a civil engineer, I became extremely desirous of having the opinion of experienced and well-informed mercantile and sea-faring people with regard to the present navigation by the Pentland Frith and the Orkneys, and the proposed inland navigation by the Caledonian canal. With the

the view of procuring the beſt poſſible information on this ſubject, I applied to Leith, Aberdeen, and Peterhead, on the eaſt coaſt; and to Greenock, Dublin, Liverpool, and Briſtol, on the weſt.

In the appendix to this report I have inſerted the queries and anſwers; by which it may be ſeen that there is only one opinion as to the dangers and inconveniencies of the preſent navigation, and the advantages which may be expected from the propoſed inland navigation, if united with a naval ſtation in the Moray Frith, or on the adjacent coaſt of Scotland.

This ſanction of experienced people, who are all deeply intereſted in commercial concerns, will, I truſt, ſatisfy your lordſhips, that it has not been upon unſubſtantial grounds that I have ventured to recommend this great national object.

My eſtimate of the expenſe of forming this navigation is nearly 350,000l., and the time required to complete it would probably be about ſeven years: this diviſion would require an annual ſupply of 50,000 l.

Upwards of thirty veſſels have been wrecked on the coaſt of Caithneſs in the memory of Alexander Miller, of Staxigo.

[To be continued.]

LVI. *On Winds.* *By* RICHARD KIRWAN, *Eſq. LL.D. F.R.S. and P.R.I.A.**

Of the Origin of the general Trade Winds.

THOUGH the origin of the general trade winds appears to me to have been fully eſtabliſhed by Dr. Halley, yet it ſeems he has explained himſelf too briefly, ſince his explanation has been miſunderſtood by many, and was thought obſcure even by d'Alembert †.

To underſtand it more perfectly, let us ſuppoſe the ſun for the firſt time in the meridian, and to communicate its heat every inſtant fifteen degrees all around. If it were to remain in this ſituation the ſurrounding air could have no other motion but upwards, for the lateral dilatations being equal, would neceſſarily check each other, but in the ſecond, and all the ſucceeding inſtants, the ſun moves weſtwards; therefore, of the originally equidiſtant eaſtern and weſtern points,

* From his paper entitled "Of the Variations of the Atmoſphere 1801."

† Sur la Cauſe des Vents. v.

the weſtern, to which the ſun approaches nearer, is more heated than the eaſtern, from which the ſun recedes; therefore in this, and all the ſucceeding inſtants, the eaſtern, being more cooled, will preſs on the weſtern, and thus an eaſtern wind will be eſtabliſhed.

It is true, that, in the northern hemiſphere, the northern air alſo preſſes upon the more heated ſpaces; but as this alſo follows the ſun's path to the weſtward, it becomes alſo eaſterly, preſerving only a few points of its primitive direction. D'Alembert adds alſo the ſolar attraction, which, according to him, elevates the air in the points over which the ſun is vertical, and conſequently produces a dilatation advancing from eaſt to weſt. But M. De la Place, not denying this cauſe, conſiders it too weak to produce ſingly any conſiderable effect *.

About the year 1735 Mr. Hadley publiſhed a very different account of the origin of the trade winds (Phil. Tranſ. Abrid. viii. p. 500); which, however, has been rejected by the moſt diſtinguiſhed aſtronomers that have ſince attended to this object, as d'Alembert, ſur la Cauſe des Vents, art. 376 and 385; Gentil Voy.; Bergman Erde Beſchreib. ii. p. 91.

According to Mr. Hadley, the air, being rarefied towards the equator, is conſequently invaded in the northern hemiſphere by the northern, and in the ſouthern hemiſphere by the ſouthern colder air.

But as the parallels of latitude enlarge as they approach the equator, and as the equatorial ſpace is nearly in the proportion of 1000 to 917, the difference of their circumference is nearly 2083 miles; conſequently, the ſurface of the globe at the equator moves ſo much faſter than under the tropics; and hence the northern or ſouthern air, moving from the tropics towards the equator, muſt poſſeſs leſs velocity than the parts it arrives at, and conſequently appear to move in a direction contrary to that of the earth's motion; which being from weſt to eaſt, the air arriving ſooner at the weſtern parts, will appear to move from eaſt to weſt; and this relative motion being combined with that towards the equator, a northeaſt wind will be produced on the north ſide, and a ſouth-eaſt wind on the ſouth ſide of the equator. Theſe as they approach the equator ſhould become ſtronger and more eaſterly, and appear due eaſt in the equator itſelf, by reaſon of the concourſe of both currents from the north and from the ſouth. There the velocity of each ſhould be at the rate of 2083 miles in the ſpace of one natural day, or above 1·33

* Mém. Paris 1776.

miles

miles per minute, if it had not been that before the air at the tropics could arrive at the equator, it muſt have gained ſome motion eaſtwards from the ſurface of the earth or ſea, whereby the relative motion is diminiſhed to the degree that actually exiſts in it.

This theory appears to me rather ingenious than ſolid, for the following reaſons:

1. The trade winds are commonly gentle, moving only at the rate of eight miles an hour; therefore they have ſufficient time to gain or participate of the motion of the earth; therefore their contrary courſe muſt ariſe from an abſolute cauſe, and cannot be deemed merely relative.

2. Becauſe the north-eaſt wind ſcarce ever approaches nearer than eight or ten degrees to the equator, and there dies away; whereas it ought there, according to this theory, to be ſtrongeſt. And, on the contrary, the ſouth-eaſt paſſes the equator ſeveral degrees, even when the ſun is in the ſouth tropic. A fact which, as Gentil remarks, is abſolutely irreconcileable with this theory. (Gentil Voy. i. p. 638; Ibid. v. p. 116.)

3. Becauſe, if the conſtant eaſterly wind was in the northern hemiſphere ſupplied ſolely from the north, and in the ſouthern hemiſphere ſolely from the ſouth, we ſhould in the former have a conſtant north wind at leaſt at 35 or 40 degrees from the equator, or at leaſt from ſome northern point, and in the latter a conſtant ſouth wind, or at leaſt from ſome ſouthern point; whereas, on the contrary, a ſouth wind often prevails in thoſe latitudes on the north ſide of the equator, and a north wind on the ſouth ſide. Thus La Perouſe met an E. S. E. in north latitude 32°, and a due eaſt in latitude 31°; and a S. S. E. in latitude 14°, and a due eaſt in latitude 16°; and a due north in latitude 20°, (where then was the relative motion?) and a due ſouth in latitude 33°. (See his Journal in La Peyr. Voy. iii.) He alſo met with a due north in latitude 27° and 42° ſouth, and a N. N. E. in latitude 25° ſouth. So captain Cook met a S. S. E. wind in latitude 30° north, and alſo in latitudes 40° and 41°, and a due ſouth wind in latitude 38° and 20°; and in the ſouthern hemiſphere a due north in latitude 3°, 4°, and 44°. I might produce other inſtances from ſea journals, and particularly from that, moſt ample and inſtructive, kept by major Dalrymple during a voyage to the Eaſt Indies (Phil. Tranſ. 1778); but I think the alleged ſufficiently prove that the general eaſt wind is not ſupplied ſolely from the north or ſouth in the different hemiſpheres reſpectively.

4. Becauſe, during our ſix ſummer months, when the ſun is in or approaches to the northern tropic, the eaſterly trade wind

wind partakes lefs of the northerly, than when the fun is in or approaches to the fouthern tropic, (Phil. Tranf. Abrid. ii. p. 134; and Schued. Abhandl. 1762, p. 175:) which is directly contrary to Hadley's fyftem; for when the fun is in the fouthern tropic, the north wind muft traverfe more of that fpace in which the earth's motion eaftward is ftrongeft, and therefore fhould participate more of that motion, as Hadley himfelf ftates: though ftill partaking of it in a fmaller degree than that which the globe itfelf poffeffes, it fhould appear to move weftwards; yet it fhould proportionably retain lefs of its original direction from north to fouth than when it had traverfed a fpace more diftant from the equator, whereas the fact is that it retains more, and often paffes into the fouthern hemifphere into the 13° fouth latitude without having any eaftern direction, (Marchand iii. p. 551;) and an analogous fact is obferved with refpect to the fouth-eaft wind when the fun is in the northern tropic. Hence it is evident, that it is from the approach of the fun, and not from the latitude traverfed, that the eaftern direction is derived; nay, the wind is often more eafterly than northerly between latitude 23° and 28°: (Fofter's Obfervations, p. 126.) He even obferved that the trade winds extended far beyond the tropics when the fun is in the fame hemifphere, which fhows it is the fun that caufes them.

Eddy is a term introduced on this fubject, which explains nothing when its caufe is not affigned and proved; the trade winds are often interrupted by the approach of land; but the interruption, as Fofter mentions, extends only to a few miles. Ibid. 127.

The *monfoons* or periodical trade winds depending on local circumftances, fufficiently explained by Dr. Halley, I fhall here pafs over; though certainly much may be added from obfervations made by fubfequent navigators and travellers. I fhall therefore confine myfelf to the *variable* winds, a fubject much more obfcure.

Of Variable Winds.

With refpect to winds we muft lay down one general and fundamental principle, which is, that they always originate at the extremity of that point towards which they proceed. Thus the eafterly trade wind begins at the point neareft the fun, which it follows, and is perpetually renovated and fupplied from parts ftill more eafterly. Thus in the year 1709 a north wind was fooner perceived in England than at Dantzic (Phil. Tranf. Abrid. iv. part ii. p. 115. And Wargentin notes, that when the wind changes to the weft, this change takes place at Mofcow before it happens at Abo, which is

feveral

ſeveral degrees weſt of it; and ſooner in Finland than in Sweden. (Schwd. Abhandl. 1762, p. 195.) And Dr. Franklin, in his xxxvith Letter, p. 389, thinks that the north-eaſt ſtorms in North America begin firſt, in point of time, in the ſouth-weſt parts; that is to ſay, ſooner in Georgia than in Carolina, and ſooner in Carolina than in Virginia, &c. He found that a north-eaſt ſtorm began at Philadelphia at ſeven o'clock, but did not extend to Boſton (about forty miles to the north-eaſt) until eleven o'clock. The reaſon of which he well explains, as the current muſt begin in the places neareſt to that in which the rarefaction ariſes, towards which the current is directed.

Of Weſterly Winds.

That eminent and laborious meteorologiſt C. La Cotte, infers from numerous obſervations of many years, that between latitude 47° and 60° on the weſtern ſide of our hemiſphere, the weſt wind, with ſome participation of the north or ſouth, is that which obtains ofteneſt. (Roz. Jour. xxxix. p. 267.) Leche obtained the ſame reſult at Abo, latitude 60°, from twelve years obſervations; Muſchenbroeck, in Utrecht; Mr. Dalton, in Weſtmorland, latitude 54°, (ſee his Meteorological Eſſays, p. 48 and 88,) from five years obſervations.

This wind in our continent originates in the Pacific Ocean between the above-mentioned parallels, at leaſt in winter; the air incumbent on that ocean is then much warmer than that of Siberia and Chineſe Tartary that lie weſt of it; this therefore preſſes upon and flows into the ſupra-marine, and is immediately ſucceeded by air ſtill further weſtwards, and thus a current is gradually eſtabliſhed extending to the Atlantic, which, though in winter, being much warmer than the air of the iſlands and continent on which it flows, is forced into the current, both by the rupture of the equilibrium to the eaſtwards, and by the preſſure of the much colder air of the continent of North America.

Of Eaſterly Winds.

During the winter months there ſeems to be a frequent ſtruggle and conteſt betwixt the air incumbent over the Aſiatic continent and that incumbent on the North American lying betwixt the above-mentioned parallels and bordering on the Pacific Ocean, which of them ſhall rule over it.

The maſs of the American air being leſs conſiderable, and its efforts divided between the Pacific and the Atlantic, is generally obliged to yield to its antagoniſt; though ſometimes the Aſiatic being warmed, either by a diffuſion of the ſuperior

perior current or by ſoutherly winds, the colder American becomes more forcible. In ſummer this muſt happen frequently, the E. N. E. ofteneſt prevailing: upon the whole, however, Leche remarked that the eaſt and E. S. E. were nearly the moſt uncommon; as did La Cotte in the climate of Paris. (Meteorolog. p. 305.)

With us this wind is moſt frequent in the months of April and May; and I have obſerved in Cook's Journal, tables 9th, 10th, and 11th, that it prevails alſo in the ſame months in the Pacific, therefore the colder continental air then pours in upon us.

La Cotte alſo obſerves, that in the weſtern tracts of Europe, in latitudes below 48°, this wind occurs ofteneſt during the winter months *; for the ſuperior heat of the Atlantic in the low latitudes determines the colder air incumbent on Hungary and European Turkey to flow in upon it.

Of Southerly Winds.

A few years ago, no problem in meteorology appeared to me more difficult than to aſſign a cauſe for the frequent prevalence of a ſouth wind even in winter, it being contrary to the laws of nature that warm air ſhould ruſh upon colder; yet I ſince diſcovered that the conjectural ſolution I then offered is grounded on a real fact.

In the eaſtern parts of our hemiſphere, from longitude 72° to 160°, that is, from the coaſt of Malabar to the Moluccas, it blows from the north-eaſt conſtantly from October until April. Now this northern blaſt muſt be ſupplied and recruited from countries ſtill further north until we arrive at the pole, and the polar air muſt conſequently be ſupplied by that which lies ſouth of it, and thus a ſouthern current is eſtabliſhed on the weſtern ſide of our hemiſphere.

Inſtances to ſupport or contradict this theory do not often occur; yet I have found ſome that appear to me deciſive, independently of the general reaſon alleged. Thus I find in the ninth table of the third volume of Cook's Voyages, that in north latitude 59°, and eaſt longitude 207°, on the 25th of May 1778, a ſtrong north-weſt wind prevailed; and on the 29th day of the ſame month and year, an equally ſtrong ſouth-weſt wind prevailed at Peterſburgh, latitude 60° and longitude 30° eaſt. Now the places of obſervation were 177 degrees diſtant, one on the eaſtern and the other on the weſtern ſide of our hemiſphere, (which, at this proximity to the pole, argues not a ſuperior diſtance to that I have men-

* Mem. Meteorolog. ii. p. 189, &c.

tioned;)

tioned;) and four days is as ſhort a time as can be allowed to the ſouth-weſt to ſupply the more eaſtern north-weſt. (Mem. Peterſburgh 1778, p. 92.) So alſo in the ſame journal I find, that from the 4th to the 30th of May a north wind prevailed in the eaſtern part of our hemiſphere from latitude 58° to 61°, except ſeventeen days of variable winds; but in London it blew from the ſouth-weſt during the firſt fifteen days of June, thus replacing the northern air. And to replace the conſtant north-eaſt wind on the Indian peninſula to the Moluccas, there is a conſtant draught from the ſouth in the weſtern parts of our hemiſphere; accordingly Leſke obſerved, that on an average of twelve years it blew 126 days each year, from October until May, from ſome ſouth point, namely, 86 days from the ſouth or ſouth-weſt, and 40 from the ſouth-eaſt, at Abo, latitude 60°.

It is true, that he found it to take place very frequently alſo in ſummer; but this is occaſioned by the great heat that then prevails in the northern tracts of Lapland.

And, upon the whole, more of the ſouth air is drawn off in winter than in ſummer; for its flow is gentle in ſummer, but often ſtormy in winter. See Leſke's 9th, 11th, and 12th tables. If all other meteorological tables of a ſeries of years had been arranged with equal ſagacity and preciſion as thoſe of Leche and Dr. Horſeley, a vaſt fund of information might be extracted from them.

At Peterſburgh, during the year 1793, Euler junior found a ſouth or ſouth-weſt wind prevailed 79 days, 52 from October to the end of March, and only 27 in the ſummer months: it was ſtormy in November, December, and January. I have not noted the ſouth-eaſt.

Mr. Stritter alſo found the ſouth wind to predominate at Moſcow during the ſix winter months of that year, (N. Acta Petrop. xi. p. 569;) ſo that the frequency of this wind in high latitudes is certain.

Of Northerly Winds.

In the weſtern parts of our continent and hemiſphere theſe are of all others the leaſt frequent in latitudes above 48°. See La Cotte's and Leche's tables. The cauſe of this unfrequency appears from what has been ſaid of ſouth winds.

But in latitudes below 48° they occur oftener, and ofteneſt in thoſe that are ſtill lower, as La Cotte remarks. An admirable inſtance of Divine Providence, that the warmeſt winds ſhould prevail ofteneſt in winter in the coldeſt regions, and cold winds in the warmeſt!

But it may be aſked, why a ſouth wind ſhould not prevail

in the eastern parts of our hemisphere to supply the constant north-east wind that prevails in the low latitudes of the western side? The reason is, that on the western side the north-east winds of low latitudes are easily supplied by the contiguous Atlantic, which is open up to the North Pole; and, as here, the upper current sets and ceases, there can be no deficiency of air.

Of opposite concomitant Winds.

It has often been observed *, but of late, since the invention of balloons, evidently proved, that currents of air from different and even opposite points of the horizon, prevail at different heights in the atmosphere over the same tracts of land or water. This was originally inferred from the different courses of the higher and lower clouds; but as such observations were often liable to optical deceptions, better proofs were wanting.

Mont Louis is within thirty miles of Perpignán, but about 5000 feet higher. Now in March 1780, north and north-east winds prevailed at Perpignan and a westerly wind at St. Louis. In August a north wind prevailed at Perpignan and an east at Mont Louis. Mém. de la Société de Medecine de Paris 1780. Derham suspected †, and Gentil has since shown, that changes of seasons constantly begin in the upper atmosphere; while a strong wind blows from one point below, a wind from an opposite point reigns above, but more gentle, until at last (in about three weeks) it is propagated downwards. (Voy. ii. p. 23, 24, in 8vo.) The lower atmosphere, he says, extends to the height of 2880 feet. (Vol. iv. p. 48.) At the commencement of winter, when the sun approaches the south tropic, and the north air begins to flow in and follow it, it must meet with more resistance from the lower denser air, as its impetuous course in an opposite direction is more slowly altered (this respects the monsoons) than in the rarer superior strata; and the same effect, but in a different direction, takes place when the sun approaches to the northern tropic.

It has been said by many, that winds in the superior regions of the atmosphere are much more violent and impetuous than in the lower. (Saussure Hygrom. p. 300: Ulloa's Voy. ii. p. 81: Muschenbr. § 2612: Bergm. Erde kugel. ii. p. 99: De Luc, &c.) But the contrary has also been observed by Gentil, above quoted, and Morveau. (Aërost. de Dijon.)

* Ulloa's Voy. ii. p. 62. English.
† Phil. Transf. Abridg. iv. part ii. 125.

Of

Of the Succession of Winds.

Well established general laws on this head would be extremely useful, as we might then foresee what wind might next be expected. Besides the *general* succession in an open country, it is probable there is a *local*, confined to certain situations.

Gentil remarks, that in the southern latitudes of our hemisphere, a north-east is succeeded by an east, south-east, and south. According to La Cotte, the order of succession in the middle latitudes is south-west, north, west, north-east, south, north-west, east, south-east. (Roz. Journ. xxxix. p. 267.)

Of the Scirocco.

This is a south or south-east wind, known in the southern parts of Italy, Sicily, and Malta, distinguished by peculiar debilitating effects, well described by Brydone, and by Dolomieu in his Treatise on the Temperature of Malta. The latter has shown that its malignity results from the constitution of the air it conveys, and not merely from its temperature, which is variable, from 55° to 80°. It contains a much smaller proportion of oxygen than air usually does. The constitution of the African wind, called *harmattan*, is as yet unknown; it is, at least on land, loaded with some unknown undissolved vapour, and is much hotter and drier than the *scirocco*, but not debilitating, and even wholesome for animals; for though it parches their skin, it destroys infection and cures several disorders. (See Phil. Trans. 1781, p. 46, &c.) Its direction is also westwards.

LVII. *Report presented to the Class of the Exact Sciences of the Academy of Turin, January* 12, 1803, *on the Action of Galvanism, and the Application of this Fluid and of Electricity to Medicine.* *By* A. M. VASSALI-EANDI *.

THE Galvanic experiments made on the 10th and 14th of August last, in the presence of a great many spectators, by Giulio, Rossi, and myself, on the head and trunk of three decapitated criminals, an account of which has been published, gave rise to several questions in regard to this agent, and by analogy respecting electricity. These two fluids, and the uses to which they may be applied, have become a common subject of conversation among well-informed per-

* From the *Journal de Physique*, Germinal, an. 11.

 sons,

fons, and, as is always the cafe with new difcoveries, their ufes are exaggerated by fome, and defpifed by others. This diverfity of opinion induced our affociate Charles Boffe to propofe to me two queftions, which I endeavoured to folve in the next letter I wrote to him about the end of September. I could eafily increafe the number of cures obtained by means of Galvanifm and electricity, as well as of the misfortunes occafioned by the action of thefe fluids and of the inftances where I obferved a conftant relation between the moral part; that is to fay, the ftrength of mind, the courage of the victims to juftice, and the effects of the Galvanic fluid on their bodies: but thefe obfervations belong to the general report of the experiments which we made fince the 14th of Auguft. I fhall therefore only prefent to you the letter which I wrote at that period.

"You afked me in one of our late academic fittings, why, after fo many experiments, made by the firft philofophers of the laft century, on the electric fluid, fuch a variety of opinions is entertained in regard to its medical action in the human body; and whether Galvanifm feems already to promife refults more ufeful to the healing art. I fhall here give you my opinion on thefe queftions, or rather fubmit to you the inductions which different experiments made by myfelf, or at which I affifted, gave me reafon to deduce with more certainty than I durft venture to hope when I began to pay a ferious attention to this object.

"I confider Galvanifm as a modification of electricity—a modification which renders this fluid more active; as the fmall flame feparated by the blow-pipe is far more ardent than the large one from which it is taken. I have read to the clafs feveral experiments which feem to fupport this comparifon between electricity and Galvanifm. Animals which were only ftunned by the ftrongeft fparks from a magic picture, were killed in lefs than three minutes by a very weak degree of Galvanifm.

"The fluid of a pile compofed of 25 plates of filver and zinc of the fize of a crown-piece, intermixed with pieces of pafteboard moiftened in water faturated with muriate of ammonia, oxidates the metals in decompofing the water, while it is fcarcely fenfible in the fingers, and gives only fmall fparks. The brilliant electric fparks which excite in our bodies a ftrong fenfation of pricking, neither oxidate the metals nor decompofe the water if they do not communicate a fhock. Having made the Galvanic current to pafs through the body of a frog, its fluids were decompofed, and I faw it fwell up fo much that it could no longer plunge into the water though poffeffed

poffeffed of great vitality, which I never obferved to be the cafe in frogs when tormented by ftrong electric fparks. All thefe facts, to which many more of a fimilar kind might be added, confirm the great activity of Galvanifm in comparifon of electricity. Hence it refults, that the fluid of the Voltaic pile may be very ufeful in cafes in which common electricity would not have fufficient activity. You are acquainted with fome of the experiments which I made in conjunction with my colleagues Giulio and Roffi: we made others, ftill more interefting, which have determined phyfiological facts, before doubtful for want of being verified. We then tried an application of it in feveral difeafes with the greateft fuccefs. Three of the cafes are as follow:

"A lady about thirty years of age, after fevere pains in the head, loft the fight of the right eye. C. Roffi being confulted in regard to this malady, after a clofe examination of the eye, which appeared to be as found and to look as well as the left, concluded that it muft arife from a palfy of the optic nerve, or what is called a *gutta ferena*, which fuffered the patient to fee only, as it were, through a thick mift; which increafed her misfortune, fince it deranged the fight of the other eye, fo that fhe was always afraid of falling, not being able to diftinguifh well with the right eye the objects which fhe handled. Roffi being fick, fent her to me, that I might make an application of Galvanifm. I formed a pile of thirty pairs of plates like thofe already mentioned, and employing gold wire as conductors, I caufed the Galvanic current to enter near the exterior angle of the eye, and to iffue fometimes at the eyebrow, fometimes by the ophthalmic ramus which paffes through the orbital foramen, and fometimes near the interior angle of the fame eye. The operation was very painful; it caufed abundance of tears to flow; but, after fucceffive Galvanic fhocks for half an hour, the eye began to fee a little better. That I might not fatigue my patient too much, and that nature might have time to act, the operation was fufpended till the evening, when it was repeated for half an hour. The next day the eye began to diftinguifh the figure of bodies. Having repeated the operation for three days following, the lady was not only able to diftinguifh the figure of bodies, and people's features, but alfo the pupils of their eyes. Before this operation, in confequence of a confultation with Dr. John Baptift Anforini, firft phyfician of the Hofpital de la Charité, I had Galvanized a young woman, twenty-feven years of age, of a melancholy temperament, who, after fome flight attacks, had a hemiplegia of the right fide, which affected in particular the arm,

 the

the cheek, and the eye. The other symptoms were removed by bleeding and the use of the remedies usual in such cases; but the eye always remained fixed, with pains in the muscles. The application of Galvanism for ten minutes was sufficient to excite abundant tears and a discharge of a watery fluid from the nose on the side which had always been shut since the attack of the disorder, and greatly alleviated the pains of the muscles. She could even turn her eye to both sides; but she found great difficulty in raising or lowering it, with a sensation of heaviness all around the eye. This operation being repeated, after the interval of a day the eye acquired its former freedom of motion, and the patient was freed from every sensation of uneasiness.

"These two operations were performed in the presence of several persons, and executed almost entirely by C. Hyacinth Carena, lecturer on natural philosophy in the National College of Turin.

"The advantages of Galvanism will appear to you still more decisive, by the cure of a person labouring under hydrophobia, performed lately by C. Rossi, who will give a full and complete account of it in a memoir on which he is now employed.

"A man bit in the finger by a mad dog, came to consult him, in consequence of a pain which he felt in the arm, the back, and particularly the finger, which had been bit more than a month. A caustic applied to the finger removed the pain; but a few days after it returned, accompanied with symptoms of hydrophobia. The patient could no longer look at water without horror; an inflammation in the throat prevented him from swallowing even chewed bread, and he experienced a strong propensity to bite those around him.

"In this state he was brought to C. Rossi, who observing that he could not bear the sight of water, nor that even of shining bodies, provided in another room a pile consisting of 50 pairs of plates of silver and zinc intermixed with 50 pieces of pasteboard moistened with a solution of muriate of ammonia. He employed slips of brown paper moistened as a conductor, on which the naked feet of the patient were placed, and at the moment when he opened his mouth to bite, one end of the arc was thrust into it, while the other communicated with the pile. The patient suffered a great deal from this operation, which after several shocks weakened him so much that he could no longer support it. Being stretched out on the floor, he was then Galvanized with ease: the operation made the sweat run from him in drops. After some time Rossi caused the patient to be conveyed home, and

gave

gave orders that he should be brought back next day, that the operation might be repeated. It was two o'clock in the afternoon when the patient was Galvanized, and at six next morning he came to Rossi himself to tell him that he was completely cured, as he experienced no pain or difficulty of swallowing, and was entirely freed from his aversion to water and to liquids: no persuasion, however, could induce him to submit to a new operation.

"But a few days after, some slight pains having given him reason to apprehend a new attack of hydrophobia, he returned to Rossi, who by repeating the operation made all the symptoms disappear. This cure was also effected in the presence of several persons. The patient was endowed with so great sensibility, that for more than a month after he felt in the shoulders a sensation of the Galvanic shocks, which I felt only as far as the articulation of the finger, though I am not one of the least sensible. You see by these trials what are the advantages which may be hoped for from Galvanism. I entertain no doubt that a mean so active may preserve from the grave many individuals, by Galvanizing them at the moment when the play of the vital organs is suspended by an accidental cause.

"This will become more evident by an explanation of the medical action of electricity on the human body.

"Several celebrated writers have classed electricity among those remedies which are most certain and most active; others have shown the inutility, and even danger, of this fluid considered as a remedy; and both seem to be supported by well attested facts.

"Nothing, however, can be more easily explained, if we reflect, that most of those who have applied electricity to medicine have been guided by quackery, without consulting the nature of the disease, or of the agent which they employed. For this reason I stated in the memoir which is about to appear in the Transactions of the Academy, that the greatest circumspection should be observed in the use of Galvanism, which, like electricity, may be attended with bad consequences; and even advanced, that the latter, though a very good remedy of itself, has done more hurt than good by improper application.

"I shall not here speak of the chemical properties which during the enthusiasm of novelty has been ascribed to electricity, such as that of transfusing into the human body the action of remedies enclosed in glass tubes, by rubbing it with them.

"It is well known that it is the fate of new discoveries to be

exaggerated, so that their adversaries easily find reasons to oppose them; but after some time things come to their proper level, established on a more complete knowledge of the agent; and those well acquainted with the properties of electricity are able to distinguish the cases in which it may be administered with advantage, from those in which it would be only prejudicial. Of ten patients affected with the same disease, which undergo the same electric treatment, five may be entirely cured, and the other five be exceedingly ill.

"Those who are cured extol electricity as the best of remedies; those who have suffered, say that it only aggravates the evil. Both speak from correct experience, and at the same time right and wrong, for attempting too much to generalize; that is to say, because they do not distinguish the cause of the disease which requires or opposes the application of electricity. Thus the same pain, the sciatica * for example, may be occasioned either by a stagnation of the fluids, by their too great abundance, or by the want of reaction in the solids: it may arise also from organic defects; an alteration of the fluids; a poisonous, or, as it is called, *acrid* principle; or from a peculiar virus in the fluids.

"The five patients who labour under a stagnation of the fluids, receive the greatest relief from electricity, which puts them in motion; the other five, tormented by sciatica occasioned by vitiated humours, will grow worse under electric treatment, which will increase the acridity of the humours, carrying off a part of the water which kept the poison diluted. This theory of the effects of electricity in the human body is founded on the nature of this fluid, and on its properties established by numerous experiments. The electric fluid tends always to put itself into a state of equilibrium, and this tendency is so strong, that it penetrates to a certain distance in the air, and extends along idio-electric bodies. It is this tendency which causes water when electrified to flow from capillary syphons, whereas a very few drops only flow without this electrization. It is by the same tendency that the electric spark, when it passes from one conducting body to another by non-conducting substances, carries with it in its passage conducting particles which serve it as a vehicle, if the solidity of the bodies does not oppose a very strong resistance. This property, proved by the common effects of thunder, and by several experiments, serves to account for the

* Dr. Balbis observed to me, that sciatica of every kind may be accounted for without recurring to the hypothetic alteration of the fluids. I replied, that I wished only to compare my theory with the principal theories of sciatica, without concerning myself with their probability.

great

great evaporation of electrified liquids, and for the greater perspiration of animals and vegetables which have been electrified. It is then evident, that whenever a stagnation of the fluids takes place, if other symptoms do not oppose it, electricity will be a good remedy: on the other hand, if the disease arises from vitiated fluids, or a virus diluted in them, electricity in this case, either by the evaporation of the diluting fluid, or by the greater alteration it may produce, will be hurtful. From what has been said, it is evident that electricity and Galvanism ought to be employed with the greatest circumspection, and that the nature of the disease ought to be compared with the nature and properties of these fluids, to ascertain whether the application of them is proper or not. It is to be observed also, that this remedy, in consequence of its activity, may be dangerous, like all other remedies, however good, if abused.

"I could adduce several instances of misfortunes occasioned by the abuse of electrization, even in cases in which a little time before it had been indicated; but I shall mention only one fact in regard to Galvanism:—A young woman was cured by Galvanism of pains which she experienced in the muscles of the face. After the cure, having continued to Galvanize herself, she did hurt, which increased with the application of the Galvanism, and did not cease till she abandoned herself entirely to the powers of nature, assisted by good nourishment. The patient then, who is incapable of forming a proper opinion respecting the state of his health, should consult a good physician, one of those who do not despise natural philosophy and the new discoveries, in order that he may never suffer by the application of electricity or of Galvanism, which, as Boerhaave says of another very active remedy, *Mira præstat in multis incurabilibus; at prudenter à prudenti medico abstine si methodum nescis* *.

LVIII. *Account of some Remains of a Species of gigantic Oxen found in America and other Parts of the World.* By Mr. Rembrandt Peale †.

AMONG the remains of gigantic and unknown animals found in America, we have lately discovered one of the ox or buffalo kind, which was taken from the bed of a creek falling into the Ohio, 12 or 14 miles north of Bigbone-lick, and presented by Samuel Brown, of Kentucky, to the Philoso-

* Elem. Chemiæ, pars iii. processus 198.

† Communicated by the Author.

phical Society at Philadelphia. By permiſſion of the society I made a plaſter caſt of this extraordinary bone, which I have now with me in London, and of which I ſend you an accurate drawing, repreſenting the back part of the head, with the condyles of the neck, and the pith or internal part of the left horn at the baſe, (See Plate VI.) The right horn is broken off, and all the fore part of the head; but from the fragment remaining it is a reaſonable conjecture that the buffalo to which it belonged was about 10 or 11 feet high. The horn at the baſe meaſures 21 inches in circumference, and tapers very gently towards the extremity, where it is broken off; ſo that the horn could not have been leſs than ſix feet in length. From the middle ſuture on the head to the baſe of the horn meaſures $7\frac{1}{2}$ inches; conſequently the two horns were 15 inches diſtant; which muſt have been increaſed when they were partly covered with fleſh, ſkin, and hair.

It is very extraordinary that bones of this kind have been occaſionally found in Siberia, in Italy, Germany, and other parts of Europe, though not quite ſo large as this American bone; which circumſtance, ſtrengthened with others of a ſimilar nature, muſt prove, either that theſe great animals have inhabited thoſe various countries, or that their remains have been forcibly ſcattered by the action of water.

Buffon informs us *, that in the pariſh of Haux, a mile and a half from Langoiran, in the ſplitting of a great rock, ſome large bones, moſtly petrified, were diſcovered; probably of the ox kind, but of a very great magnitude. He likewiſe mentions †, that in 1772 there was found near Rome an ox's head in a ſtate of petrifaction. The length of the forehead between the two horns was 2 feet 3 inches; the diſtance between the orbits of the eyes 14 inches; that from the upper portion of the forehead to the orbit of the eyes, 1 foot 6 inches; the circumference of one horn, 18 inches; the length of the ſame following the curve, 4 feet. "This inſtance is ſufficient to prove," ſays Buffon, "that there have been prodigious giants among this ſpecies of animals; but it is further confirmed by other facts." He then enumerates ſeveral bones of the ſame kind in the muſeum at Paris ſimilar to ſome which I have remarked in the Britiſh muſeum.

In the Philoſophical Tranſactions ‡ there is an engraving and an account of a bone of this kind, found near the city of

* Quarto Supplement, vol. v. p. 486. † Page 543.
‡ Vol. xxxvii. p. 427.

Dirſchaw,

Dirschaw, of very large dimensions, and having the same characters which distinguish the one found on the Ohio.

Until the discovery of this bone in America, the tradition of the Indians concerning the great buffalo has been considered as entitled to very little attention. Many interpreted it as having entire reference to the mammoth, whose pre-eminent size was obvious, and whose carnivorous teeth were well calculated to excite terror; but I have now no hesitation in believing that the tradition, which, with such little variation, prevails through all North America, mentioning the antient existence of a great buffalo, is a tradition really handed down to them from their forefathers, but, like all other traditions, clouded with fable: yet it is not improbable, since we find the remains of the mammoth and the great buffalo in the same country, that the distinct ideas of each have been in time confounded, the terrible *power* of the one with the *name* of the other.

It has been too much the custom, whenever any large bones have been found in Europe, to call them all elephants' bones; and in America, to think them all belonging to the mammoth: but from the progress now made in this inquiry there is reason to hope for additional light on this interesting subject, whether it be considered as a foundation to theological faith, or regarded as a conspicuous monument in the history of the world.

LIX. *Description of the* Nymphæa Cærulea. *By* JULIUS CÆSAR SAVIGNY, *of the Institute of Egypt**.

IT is well known that the lotus of the antient Egyptians was one of the most celebrated plants of antiquity. Rising every year with the waters of a river which overflowed its banks only to fecundate the earth; springing up amidst plains formerly desert, which it embellished with its beautiful flowers; and cultivated to serve as food to the least sensual, but the most numerous class of the inhabitants; it was judged worthy of homage by one of the first people in the world, who considered it as the happy sign of abundance, and as a sacred pledge of the favour of the gods.

It is to the genus of the *nymphæa* that the modern botanists have referred the lotus, which has been described by most of the antient historians, and which is engraven on all the antique monuments of Egypt. Two species of this genus,

* From *Annales du Museum National*, No. 5.

one with white and the other with azure flowers, ſtill ornament, during the time of the inundation, the ſurface of the canals and rivers, and in general of all the fields of Lower Egypt, which are covered by the waters of the river. Plants ſo ſimilar were no doubt beheld by the Egyptians with equal veneration; and though Linnæus, who was well acquainted with the former, gave it the name of *lotus*, it is to be preſumed that the ſecond procured the ſame advantages and ſerved for the ſame myſteries. Its flowers have more ſplendour and a ſweeter ſmell, and the azure colour they exhibited might become, among a people ſo religious, the emblem of the reſidence of the deity on the waters.

The *nymphæa lotus* is very well deſcribed, and a good figure is given of it, in ſeveral Syſtems of Botany; but the caſe is not the ſame with thoſe the flowers of which are azure-coloured. It was ſcarcely obſerved by a few travellers, and if mentioned, it was only in a vague and incorrect manner. Forſkal, who travelled through Egypt in 1761, and who gave a Flora of that country, did not obſerve it. His ſilence in this reſpect is the more aſtoniſhing, as the plant in queſtion and the *nymphæa lotus* grow together and uſually intermix their leaves. It is not even indicated in the laſt edition of the *Syſtema Naturæ*, publiſhed by Gmelin. This author, however, collected with great attention all the ſcattered ſpecies to be found in the different works which have hitherto appeared *.

It is therefore indiſpenſably neceſſary that a name and ſpecific character ſhould be aſſigned to this nymphæa; it is alſo neceſſary that a correct deſcription ſhould be given of it: this, in ſome meaſure, will be enriching botany with a new plant; and this, indeed, is the object which I propoſe in the preſent memoir.

But as this ſpecies has a great reſemblance to the *nymphæa lotus*, and as it is poſſible that they may have often been confounded, I have thought it will be of advantage to give a comparative deſcription of both. By theſe means the reader will be better enabled to comprehend the characters by which they are diſtinguiſhed, and which render it neceſſary to form of them two ſeparate ſpecies.

The root of the *nymphæa lotus*, and that of the other ſpecies, which from the colour of its flowers I have called the azure nenuphar (*nymphæa cærulea*), conſiſt of long, white, pulpy filaments, the upper extremities of which adhere to round tubercles. In ſeveral provinces of Egypt theſe tuber-

* Wildenow in his *Species Plantarum* does not ſpeak of this nymphæa.

cles,

cles, and particularly thofe of the firft fpecies, are plucked up after the inundation: they are ufed as food; they have an infipid earthy tafte, and form a delicate difh.

The leaves of both are large, pretty numerous, fub-orbicular, divided into two lobes from their bafe to the place where the petiole is inferted; that is to fay, nearly to the middle of the difk. They are not fo thick as thofe of our nenuphars in Europe: they have a darker green colour, and a fhining appearance above; and below are often tinged with purple or violet. Thefe leaves are fupported by radical cylindric petioles, flightly compreffed and fometimes very long, which float on the furface of the water.

The flowers are very large, and are often more than four inches in diameter. Their pedicles, which arife from the root, are uniflorous and differ very little from the petioles.

The calyx of thefe flowers is compofed of eight leaves difpofed in two rows, and coloured in the infide: the more interior ones are the moft coloured, and have fome refemblance to the petioles.

The latter, from twelve to twenty in number, are alfo difpofed in feveral feries.

The ftamina are of a yellow colour with large filaments, and petaliform.

The radii of the ftigma vary, for the moft part, in number from twelve to twenty-five. They have the fame colour as the ftamina, are compreffed and flightly bent at the fummit.

Such is the common appearance of the roots, the leaves, and the flowers. Let us now examine the differences they exhibit.

The leaves of the *nymphæa lotus* are bordered quite round with very acute indentations, firm and almoft like prickles: their lobes, for the moft part, are exactly parallel and fometimes even; they converge, and mutually cover each other: their inferior furface is charged with very prominent ribs, which form a very apparent reticulation: their petioles are rough.

On the other hand, thofe of the *nymphæa cærulea* have their edges fcarcely finuated; their lobes are more pointed, and commonly divergent. The inferior furface exhibits ribs fcarcely fenfible, the principal ones of which only are fomewhat prominent; the reft being concave and lefs elevated than the difk. The petioles of thefe leaves are exceedingly rough.

In the *nymphæa lotus* the leaves are always more open. The folioles of the calyx are oval, lanceolated, greenifh externally,

nality, without ſpots, but marked with ſeven paler ribs very diſtinct.

The folioles of the calyx in the *nymphæa cærulea* are much narrower, lanceolated, and almoſt cuneiform: the exterior ſide of them is of a dark green colour, conſtantly varied with an infinite number of points and ſmall lines of a purpliſh colour, and have no apparent ribs.

The petals of the *nymphæa lotus* are oval, lanceolated, and very unequal; thoſe of the laſt being much ſmaller than the reſt: their colour is a pure milk-white, tinged with a greeniſh purple colour on the outſide, but rarely.

In the *nymphæa cærulea* the petals are lanceolated all perfectly equal, of a bright white colour, tinged, in particular towards the ſummit, with the moſt beautiful azure, inclining ſlightly however, ſometimes, to violet.

The ſtamina of the *nymphæa lotus* have antheræ very much compreſſed, lanceolated, without any appendix at the ſummit, and have ſcarcely the length of the filaments.

On the other hand, the antheræ of the *nymphæa cærulea* are very little compreſſed, lineal and longer than the filaments; their ſummit is terminated by a ſubulated blueiſh appendix ſimilar to a ſmall petal.

In the laſt place, the ſummits of the radii of the ſtigma are longer and ſubulated in the *nymphæa lotus*; ſhorter, oval, and lanceolated, in the *nymphæa cærulea.*

The ſmell exhaled from the flowers of each kind is alſo very different: that of the *nymphæa cærulea* is exceedingly ſweet and agreeable; that of the *nymphæa lotus* is ſtronger, more pungent, and much leſs agreeable.

In regard to the fruit, I did not find in them any very remarkable difference: in both ſpecies it conſiſts of a dry round berry, which is long, covered by the baſes of the folioles of the calyx and thoſe of the petals; truncated and radiated at the ſummit, which is always ſtained by the decompoſition of the ſtamina and interior petals: it is divided into ſeveral cells, each of which correſponds to a radius of the ſtigma, and contains a quantity of round ſeeds of a roſe colour.

The Arabs have very well diſtinguiſhed theſe plants, and given to each a particular name: the former they call *neoufar*, and the latter *bachenin.*

By ſelecting from the deſcription here given the moſt prominent differences, both ſpecies may be characterized as follows:

Nymphæa Lotus,

N. *foliis dentatis, antheris apice ſimplicibus.*

Nymphæa Cærulea,

N. *foliis repandis, antheris apice ſubulato-petaloïdeis.*

Explanation of the Plate. (VII.)

1. A petal.
2. A ſtamen of the interior ſeries.
3. A ſtamen of the exterior ſeries.
4. The ovarium and ſtigma.
5. The ſeeds.
6. A ſection of the pedicle.

LX. *On Mr.* GREATHEAD'S *Life-Boat**.

SIR,

A CONSIDERABLE time has elapſed ſince I had the honour to lay before the Society a model of the life-boat of my invention.

I have now encloſed a particular account of its conſtruction in a letter from Mr. Hinderwell, explaining upon what principle it is built, ſo as to render it ſuperior to any other form of a boat for the dangerous enterpriſes for which it was intended, and has been uſed.

I am, Sir, your humble ſervant,
HENRY GREATHEAD.

South Shields,
Jan. 1, 1802.

To Mr. Charles Taylor.

SIR,

IT is much to be lamented, that in an age enlightened by ſcience, ſuch a languid indifference ſhould prevail on many important public occaſions; and that the moſt excellent inventions ſhould have to combat the force of inveterate prejudice.

How many valuable diſcoveries have languiſhed in obſcurity! How many uſeful projects have periſhed in embryo, deprived of the foſtering aid of the public, and the patronage of influence and authority! In the claſs of uſeful improvements for the diminution of the dangers incident to a maritime profeſſion, the life-boat, invented by Mr. Greathead, of Shields, has a claim to a diſtinguiſhed patronage. An experimental conviction of its great utility in ſaving the lives of ſhipwrecked ſeamen, and of its perfect ſafety in the moſt agitated ſea, has induced me to advocate the cauſe with a

* From the *Tranſactions of the Society for the Encouragement of Arts, &c. for* 1802.—The Society's gold medal and fifty guineas were voted to Mr. Greathead for this invention.

zeal

zeal proportioned to its importance; and it is a consolatory reflection to my own mind, that my exertions have been successful in the introduction of a life-boat in the port of Scarborough, and, I trust, not unprofitable towards promoting a similar establishment in other places. The services which have been recently performed at this port by means of the life-boat, in contributing to the preservation of the lives of the crews of two vessels, more than compensate for every labour. I am far from the ambition of aspiring to any honorary testimony on this occasion. Actuated by the purest principle of philanthropy, my sole object is the benefit of the community, and to endeavour, by ardent recommendations, to excite a spirit of emulation in order to introduce the life-boat, with its invaluable properties, into more general use. I am induced to submit, with the utmost deference and respect, to the consideration of the Society of Arts, &c. the following description of the life-boat, with some miscellaneous observations. The construction of the boat, agreeably to Mr. Greathead's plan, is as follows:

The length is thirty feet; the breadth, ten feet; the depth, from the top of the gunwale to the lower part of the keel in midships, three feet three inches; from the gunwale to the platform (within), two feet four inches; from the top of the stems (both ends being similar) to the horizontal line of the bottom of the keel, five feet nine inches. The keel is a plank of three inches thick, of a proportionate breadth in midships, narrowing gradually toward the ends to the breadth of the stems at the bottom, and forming a great convexity downwards. The stems are segments of a circle, with considerable rakes. The bottom section, to the floor-heads, is a curve fore and aft, with the sweep of the keel. The floor-timber has a small rise curving from the keel to the floor-heads. A bilge-plank is wrought in on each side next the floor-heads with a double rabbet or groove of a similar thickness with the keel; and on the outside of this are fixed two bilge-trees, corresponding nearly with the level of the keel. The ends of the bottom section form that fine kind of entrance observable in the lower part of the bow of the fishing-boat, called a *coble*, much used in the North. From this part to the top of the stem it is more elliptical, forming a considerable projection. The sides, from the floor-heads to the top of the gunwale, flaunch off on each side, in proportion to about half the breadth of the floor. The breadth is continued far forward towards the ends, leaving a sufficient length of strait side at the top. The sheer is regular along the strait side, and more elevated towards the ends. The

gunwale,

gunwale, fixed on the outſide, is three inches thick. The ſides, from the under part of the gunwale along the whole length of the regular ſheer, extending twenty-one feet ſix inches, are caſed with layers of cork to the depth of ſixteen inches downward; and the thickneſs of this caſing of cork being four inches, it projects at the top a little without the gunwale. The cork on the outſide is ſecured with thin plates or ſlips of copper, and the boat is faſtened with copper nails. The thwarts, or ſeats, are five in number, double banked, conſequently the boat may be rowed with ten * oars. The thwarts are firmly ſtanchioned. The ſide oars are ſhort †, with iron tholes and rope grommets, ſo that the rower can pull either way. The boat is ſteered with an oar at each end; and the ſteering oar is one-third longer than the rowing oar. The platform placed at the bottom within the boat is horizontal, the length of the midſhips, and elevated at the ends for the convenience of the ſteerſman, to give him a greater power with the oar. The internal part of the boat next the ſides, from the under part of the thwarts down to the platform, is caſed with cork; the whole quantity of which affixed to the life-boat is nearly ſeven hundred weight. The cork indiſputably contributes much to the buoyancy of the boat, is a good defence in going alongſide a veſſel, and is of principal uſe in keeping the boat in an erect poſition in the ſea, or rather of giving her a very lively and quick diſpoſition to recover from any ſudden cant or lurch which ſhe may receive from the ſtroke of a heavy wave. But excluſive of the cork, the admirable conſtruction of this boat gives it a decided pre-eminence. The ends being ſimilar, the boat can be rowed either way; and this peculiarity of form alleviates her in riſing over the waves. The curvature of the keel and bottom facilitates her movement in turning, and contributes to the eaſe of the ſteerage, as a ſingle ſtroke of the ſteering oar has an immediate effect, the boat moving as it were upon a centre. The fine entrance below is of uſe in dividing the waves, when rowing againſt them; and, combined with the convexity of the bottom and the elliptical form of the ſtem, admits her to riſe with wonderful buoyancy in high ſea, and to launch forward with rapidity, without ſhipping any water, when a common boat would be in danger of being filled. The flaunching, or ſpreading form of the boat, from the floor-heads to the gunwale, gives her a conſiderable bearing; and the continuation

* Five of the benches are only uſed, the boat being generally rowed with ten oars.

† The ſhort oar is more manageable in a high ſea than the long oar, and its ſtroke is more certain.

of

of the breadth, well forward, is a great ſupport to her in the ſea; and it has been found by experience, that boats of this conſtruction are the beſt ſea-boats for rowing againſt turbulent waves. The internal ſhallowneſs of the boat from the gunwale down to the platform, the convexity of the form, and the bulk of cork within, leave a very diminiſhed ſpace for the water to occupy; ſo that the life-boat when filled with water contains a conſiderable leſs quantity than the common boat, and is in no danger either of ſinking or overturning. It may be preſumed by ſome, that in caſes of high wind, agitated ſea, and broken waves, that a boat of ſuch a bulk could not prevail againſt them by the force of the oars; but the life-boat, from her peculiar form, may be rowed a-head when the attempt in other boats would fail. Boats of the common form, adapted for ſpeed, are of courſe put in motion with a ſmall power, but for want of buoyancy and bearing are overrun by the waves and ſunk, when impelled againſt them; and boats conſtructed for burden meet with too much reſiſtance from the wind and ſea when oppoſed to them, and cannot in ſuch caſes be rowed from the ſhore to a ſhip in diſtreſs. An idea has been entertained, that the ſuperior advantages of the life-boat are to be aſcribed ſolely to the quantity of cork affixed. But this is a very erroneous opinion; and, I truſt, has been amply refuted by the preceding obſervations on the ſupereminent conſtruction of this boat. It muſt be admitted, that the application of cork to common boats would add to their buoyancy and ſecurity; and it might be a uſeful expedient, if there were a quantity of cork on board of ſhips, to prepare the boats with in caſes of ſhipwreck, as it might be expeditiouſly done, in a temporary way, by means of clamps, or ſome other contrivance. The application of cork to ſome of the boats of his majeſty's ſhips * might be worthy of conſideration; more particularly as an experiment might be made at a little expenſe, and without inconvenience to the boats; or may prevent pleaſure boats from upſetting or ſinking.

The life-boat is kept in a boat-houſe, and placed upon four low wheels, ready to be moved at a moment's notice. Theſe wheels are convenient in conveying the boat along the ſhore to the ſea; but if ſhe had to travel upon them on a rough road, her frame would be exceedingly ſhaken. Beſides, it has been found difficult and troubleſome to replace her upon theſe wheels on her return from ſea. Another plan has therefore been adopted. Two wheels, of nine feet dia-

* The launches.

meter, with a moveable arched axis, and a pole fixed thereto for a lever, have been conſtructed. The boat is ſuſpended near her centre between the wheels under the axis, toward each extremity of which is an iron pin with a chain attached. When the pole is elevated perpendicularly, the upper part of the axis becomes depreſſed, and the chains being hooked to eye-bolts on the inſide of the boat, ſhe is raiſed with the utmoſt facility by means of the pole, which is then faſtened down to the ſtem of the boat.

The Scarborough boat is under the direction of a committee. Twenty-four fiſhermen, compoſing two crews *, are alternately employed to navigate her. A reward, in caſes of ſhipwreck, is paid by the committee to each man actually engaged in the aſſiſtance; and it is expected that the veſſel receiving aſſiſtance ſhould contribute to defray this expenſe. None have hitherto refuſed.

It is of importance that the command of the boat ſhould be intruſted to ſome ſteady, experienced perſon, who is acquainted with the direction of the tides or currents, as much ſkill may be required in riſing them to the moſt advantage in going to a ſhip in diſtreſs. It ſhould alſo be recommended, to keep the head of the boat to the ſea as much as circumſtances will admit; and to give her an accelerated velocity to meet the wave. Much caution is neceſſary in approaching a wreck, on account of the ſtrong reflux of the waves, which is ſometimes attended with great danger. In a general way, it is ſafeſt to go on the lee quarter; but this depends upon the poſition of the veſſel; and the maſter of the boat ſhould exerciſe his ſkill in placing her in the moſt convenient ſituation. The boatmen ſhould practiſe themſelves in the uſe of the boat, that they may be the better acquainted with her movements; and they ſhould at all times be ſtrictly obedient to the directions of the perſon who is appointed to the command.

The great ingenuity which has been diſplayed in the conſtruction of the life-boat, leaves ſcarcely any room for improvement; but ſome have ſuppoſed that a boat of twenty-five feet in length, with a proportionate breadth, would anſwer every purpoſe of a larger one. A boat of theſe dimenſions would certainly be lighter, and leſs expenſive; but whether ſhe would be equally ſafe and ſteady in a high ſea I cannot take upon myſelf to determine.

Mr. Greathead, of South Shields, the inventor, under-

* Two crews are appointed, that there may be a ſufficient number ready in caſe of any abſence.

takes

takes to build theſe boats, and to convey them to any port in the kingdom. He is a worthy man, in whom a confidence may be repoſed, and will build upon moderate terms of profit.

THOMAS HINDERWELL.

Deſcription of the Life-Boat.

EEE (Plate VIII.), the ſheer or curve of the boat.

II, the two ſtems or ends.

K, the keel.

LL, the aprons, to ſtrengthen the ſtems.

MM, the ſheets, or places for paſſengers.

NN, timber-heads, or boat-faſtenings.

OOOOO, the tholes on which the oars are ſlung by grommets.

T, flooring under the rowers feet.

Fig. 2. a croſs ſection of the life-boat.

FF, the outſide coatings of cork.

GG, the inſide cork filling.

HH, the outſide planks of the boat.

I, one of the ſtems of the boat.

K, the keel.

NN, the timber heads.

P, the thwarts, or rowers ſeats.

R, one of the ſtanchions under the thwarts, each being thus firmly ſupported.

S, a ſection of the gang-board, which croſſes the thwarts, and forms the paſſage from one end of the boat to the other.

T, the floor-heads, or platform for the rowers feet.

VV, the two bilge-pieces, nearly level with the keel.

WW, the gunwales.

X, a ring-bolt for the head-faſt, there being another alſo at the other end.

Y, platform for the ſteerſman.

Fig. 3. a truck or carriage with four wheels, to convey the boat to and from the ſea.

a, an oblong frame of wood conſiſting of two long pieces, hollowed a little to admit the body of the boat, and ſecured by the croſs pieces bb.

cccc, four low wheels, each ſunk or hollowed in the middle, to run better upon a rail-way or timber-road.

dd, two indents made in the ſide timbers, that the bottom of the boat may lie firm therein.

ee, two ſmall rollers, moveable in the croſs timbers for the keel of the boat to ſlide upon.

ff, the

ff, two long rollers, one at each end of the frame, to assist in raising the boat upon or sliding it off the truck or carriage.

Management of the Life-Boat from the Boat-House to the Sea, and vice versâ, *as practised at Lowestoffe, in Suffolk.*

The life-boat may be launched from any beach, when wanted, with as much ease as any other boat, by proper assistance. The distance from the boat-house at Lowestoffe to the shore is one hundred yards, and the boat's crew can run her down in ten minutes. When the sea does not tumble in upon the beach very much, the boat may be easily launched by laying the ways as far as possible in the water, and hauling the carriage from under her.

When there is a great sea on the beach, the boat must be launched from the carriage before she comes to the surf, on planks laid across, as other boats are launched; the people standing on the ends to prevent the sea moving them; then, with the assistance of the anchor and cable (which should be laid out at sea for the purpose), the boat's crew can draw her over the highest sea.

Upon the boat returning to the shore, two double blocks are provided; and, having a short strop fixed in the hole, in the end of the boat next the sea, the boat is easily drawn upon the carriage. The boat's crew can run her any distance upon a clear shore by the carriage of Mr. Greathead's contrivance.

Account of, and Instructions for, the Management of the Life-Boat.

The boats in general of this description are painted white on the outside, this colour more immediately engaging the eye of the spectator at her rising from the hollow of the sea than any other. The bottom of the boat is at first varnished (which will take paint afterwards), for the more minute inspection of purchasers. The oars she is equipped with are made of fir of the best quality, having found by experience that a rove-ash oar that will dress clean and light is too pliant among the breakers; and when made strong and heavy, from rowing double banked, the purchase being short, sooner exhausts the rower, which makes the fir oar, when made stiff, more preferable.

In the management of the boat, she requires twelve men to work her; that is, five men on each side, rowing double banked, with an oar slung over an iron thole, with a grommet (as provided) so as to enable the rower to pull either

way; and one man at each end to ſteer her, and to be ready at the oppoſite end to take the ſtern oar when wanted. As, from the conſtruction of the boat, ſhe is always in a poſition to be rowed either way, without turning the boat, when manned, the perſon who ſteers her ſhould be well acquainted with the courſe of the tides, in order to take every poſſible advantage: the beſt method, if the direction will admit of it, is to head the ſea. The ſteerſman ſhould keep his eye fixed upon the wave or breaker, and encourage the rowers to give way as the boat riſes to it; being then aided by the force of the oars, ſhe launches over it with vaſt rapidity, without ſhipping any water. It is neceſſary to obſerve, that there is often a ſtrong reflux of ſea, occaſioned by the ſtranded wrecks, which requires both diſpatch and care in the people employed, that the boat be not damaged. When the wreck is reached, if the wind blows to the land, the boat will come in ſhore without any other effort than ſteering.

I would ſtrongly recommend practiſing the boat, by which means, with experience, the danger will appear leſs, from the confidence people will have in her from repeated trials.

LXI. *A general View of the Coal Mines worked in France, of their different Products, and the Means of circulating them. By* C. Lefebvre, *Member of the Council of Mines, of the Philomatic Society, &c. &c.*

[Continued from p. 240.]

Department of Ille and Vilaine.

No coals are dug up in this department. It may receive this fuel by ſea in the northern part; and the mines of Montrelais and North, in the department of Loire-Inferieuſe, may ſupply the ſouthern part.

Department of Indre.

This department is in the ſame ſituation as the preceding in regard to the want of coal mines. It might be ſupplied from the mines in the department of La Creuſe, if the river of that name, which is navigable for boats only to Argentan, were rendered navigable higher up.

If the navigation of the Cher were improved, it might alſo ſupply with coals the eaſtern part of the department of Indre, becauſe the coal mines in the environs of Montluçon would then become an object of importance.

Department

Department of Indre and Loire.

There are no coal mines in this department; but it receives the products of the mines of various departments by the river Loire, which traverses it in its longest direction.

Department of Isere.

The southern part of this department (22) contains some coal mines; and particularly in the environs of the communes of La Motte, Pierre-Chatêl, La Mure, Saint-Barthelemi-de-Sechilienne, &c.

They supply a mineral combustible of a moderate quality; but is exceedingly valuable in a country where wood is daily becoming scarcer.

These coal mines are almost all worked in an irregular manner, without attention to the lives of the workmen or to economy.

The annual product of these mines may be estimated at from a million to twelve hundred myriagrammes.

The price at the mines is from 15 to 20 cents per myriagramme; but the difficulty of land-carriage raises the price at Grenoble to from 60 to 80 cents.

Department of Jura.

Several indications of coals have been announced in this department; and some attempts were made to work mines, which gave rise to well-founded hopes: but these attempts are now abandoned, and no mines are worked in this department.

In the present state of things, the mines of Blanzy and Saint-Berain, in the department of Saône and Loire, furnish coals to this department by the canal of Charolois and Doubs. The southern part is supplied from the mines of Rives-de-Gier.

Department of Landes.

Indications of coal have been announced in the neighbourhood of Dax; but from the nature of the soil it is probable that it is fossil wood. As this department has no coal mines worked, it is supplied with this fuel by sea, and particularly from the port of Bayonne.

Department of Loire and Cher.

This department (23) has no coal mines. It receives this fuel by the river Loire from the mines of Haute-Loire and Allier.

Department of Haute-Loire.

Very abundant coal mines are worked in the cantons of Braſſac-Sainte-Florine, Freugères, Vergongheon, and Lempdes, the product of which is conſiderable. That of Groſmenil, ſituated in the laſt-mentioned commune, which had been perforated by a number of ſmall pits in ſuch a manner that the ſtrata of coal was inundated, is now in the hands of a company, who are clearing it of water, and making preparations for working it to a greater depth.

There is reaſon to think, that this mine alone, when in a productive ſtate, will furniſh as much as all the other mines of the country do at preſent. The annual product, however, of the latter is from fifteen to eighteen hundred thouſand myriagrammes. Theſe coals are of an excellent quality. The means of their conveyance are the navigation of the Allier and the Loire, the canal of Briare and of the Seine; which gives for their circulation an extent of more than 140 leagues. A large quantity of theſe coals is conſumed at Paris. The mean price of them at the pits is from 15 to 20 cents; and when delivered at Paris from 30 to 40 cents per myriagramme.

Department of La Loire.

The ſouth-eaſt part of this department (24) contains a great number of coal mines, worked in an extent of more than ten miles in length and five or ſix miles in breadth. The principal communes in which theſe mines are ſituated are thoſe of Rives-de-Gier, Saint-Chamond, Saint-Etienne, Le Chambon, Firnini, Roche-Moliere, &c.

In conſequence of the number and richneſs of the ſtrata found in theſe cantons, an immenſe quantity of this fuel has been extracted for ſeveral centuries paſt; but in order to obtain it ſooner, and with more eaſe, a great many pits have been ſunk, by means of which the coals neareſt the ſurface were dug out. The whole country is perforated with theſe apertures. This irregular method rendered the working of the inferior ſtrata much more laborious and expenſive.

The preſent product of the different mines in this department are ſtated at thirty millions of myriagrammes annually; and this, in all probability, is below the truth. If the mines were better worked, it is certain that the quantity might be quadrupled.

The quality and price of theſe coals is exceedingly various. Thoſe of the firſt quality coſt at the mine from 10 to 12 cents per

per myriagramme; those of mean quality are sold for 7 or 8 cents, and the worst for 5.

The medium price of these coals transported to Lyons is 15 or 18 cents per myriagramme: the price at Marseilles is 35 cents.

Department of La Loire Inferieure.

This department (25), as has been seen, may receive coals from the mines situated towards the upper part of the course of the Loire as well as from those of Allier. The coals of the mine of Decise, which will be mentioned in speaking of the department of La Nievre, are also conveyed to different places on the Loire. The coals also of the mines of Montrelais, situated two or three leagues to the north of Varades and Ingrande, are conveyed on the lower part of the Loire. They are embarked in particular at the latter place to be transported to the communes on the banks of that river descending to Nantes, where the consumption is considerable.

The coals annually extracted from these mines may be safely estimated at a million of myriagrammes. They are of a good quality. The mean price on the spot is 5 cents per myriagramme; when sent to Nantes, the same quantity costs 25 cents.

In this department there are also peat-mosses, the product of which is abundant, and of great utility to the inhabitants. The most considerable are found in the marshes of Montoire, to the north of Nantes. More than eight thousand individuals are employed in digging peat from these mosses.

Department of Loire and Cher.

There are no mines worked in this department. It receives coals by the Loire, which traverses it; and might consume those also brought by the Cher from the mines situated in the environs of Commentry and Montluçon, in the department of Allier, if the navigation of the Cher were improved.

Department of Loiret.

There are no coal mines worked in this department; but it is abundantly provided with coals by the navigation of the Seine.

Department of Lot.

Abundant coal mines exist in the environs of Figeac, towards the east extremity of this department. They are badly worked by the proprietors of the ground; but they are susceptible of improvement, if means of consumption were opened for their products.

Department of Lot and Garonne.

No coal mines are worked in this department. Thofe extracted from the mines of Carmeaux, in the department of Tarn, are brought to it on the Garonne; and it receives by the Lot thofe of the department of that name, which would be fupplied much cheaper if the Lot were rendered navigable towards Figeac and the department of Aveyron.

Department of La Lozere.

The difcovery of fome ftrata of coal in this country would be of great utility. Wood daily becomes fcarcer; and the communication with the coal countries in the neighbouring departments is difficult and expenfive.

Several indications of coal have been announced; particularly towards Canourgue, towards Mende, and in the neighbourhood of Meyrmey. Some fpecimens fent to the Council of Mines announce only foffil wood.

Department of Lys.

This department has no coal mines worked. It receives thofe of the departments of the North and of Jemappes.

Department of La Manche.

There are feveral indications of coal in this department; and particularly in the Foreft of Briquebec, near Valonges; in the commune of Pleffis, near Fretot; in that of Moon, and that of Semilly, in the diftrict of Saint-Lô.

Strata of coal have been found in the commune of Pleffi; but hitherto they are fo intermixed with ftrata of fchift, that if worked they would not pay the expenfes.

Department of La Marne.

This department, as far as is yet known, has no coal mines. Collections of foffil wood, and of peat exceedingly pyritous, are frequently found under ftrata of marly earth. Thefe fubftances have often been announced as coal, but they do not poffefs the qualities of that fuel. They kindle flowly, and become totally incandefcent; but they give very little flame, and for the moft part none at all. This fubftance is called by the inhabitants *earth coal.*

The Valley of La Vefle furnifhes abundance of peat of an excellent quality. This river, which takes its fource on the eaft of Chalons, paffes Rheims and Braine, and difcharges itfelf into the Aifne above Soiffons, traverfing an extent of eighteen leagues. It every where runs over a bed of peat, and

and may afford great resources to the neighbouring communes if that substance were properly dug up.

Department of La Haute Marne.

There are no coal mines worked in this department. Several indications of coal have been announced, but hitherto the specimens have turned out to be bituminous fossil wood. This department is at a distance from coal countries, and has on easy communication with them; but it is abundant in wood.

Department of La Mayenne.

This department is supplied with coals by the Loire. Boats can go up the Mayenne as far as Laval; and the Sarthe as far as Mons.

Department of Mayenne and Loire.

There are several small coal pits worked in the canton (26) of Saint-Aubin-de-Luigné, in the territories of Chaudefond, Montjean, and several other places adjacent. They are worked very irregularly, and the product of them is not known.

The mine of Saint-George's-Châteloison, situated between Vihiers and Doué, to the east of the latter commune, is more important and worked in a more regular manner. The product amounts to about 300,000 myriagrammes per annum; but it might be rendered more considerable.

Department of La Meurthe.

A discovery of coal has been announced in the neighbourhood of Nancy; but the specimens sent were only bituminous fossil wood. At present this department has no coal mines actually worked.

Department of the Meuse.

No coal mines are worked in this department (27). It can receive coals from La Saare by the Moselle, and the canal which communicates with the Meuse between Toul and Pagny: and the coals of the department of Ourthe may be conveyed on the Meuse to its northern part.

Department of La Meuse Inferieure.

This department possesses very important coal mines in the neighbourhood of Rolduc. The annual product of them amounts to more than 13,500,000 myriagrammes; and they are far from being properly worked.

The coals are of different qualities; some of them are very good. Their mean price at the mine varies from 5 to 14 cents

per myriagramme. There is alſo abundance of peat in the cantons of Heythnyſen, and De Weert.

Department of Mont-Blanc.

There are ſeveral coal mines in this country (28). Some are worked in the territory of the communes of Entrevernes near Annecy, Montmin, Novalaiſe, Servolex, and Petit-Bernard. Indications of coal have been announced alſo in the canton of Moutiers, Cruſeilles, Valloires, and Cognin. The annual product of the coal mines worked in this department may be eſtimated at 120,000 myriagrammes per annum. Theſe mines are ſuſceptible of improvement, but there is no conſumption. The price of the coals at the mine is 5 cents per myriagramme.

Department of Mont-Tonnere.

There are more than thirty coal mines known in this department (29). Several of them have been abandoned in conſequence of the war. The cantons moſt abundant are thoſe of Lautereck, Wolfſtein, and Obermoſchel.

The product of theſe mines may be eſtimated at about 425,000 myriagrammes; but if the conſumption required, it could be increaſed. The quality of the coal varies. There is very little of it good; but it is generally uſed for heating ſtoves. The price at the mines is 8 cents per myriagramme.

Theſe coals are conſumed merely by the wants of the country. A conſiderable quantity of them is employed for burning lime, either for building or for manure. They are employed alſo in the fuſing of mercury, of which there is very important mines in this department; and for the purpoſes of evaporation in the ſalt-works of Kreutznach.

Department of Morbihan.

The Morbihan has no coals. It receives thoſe which are dug up on the banks of the Loire, or of the rivers united with it.

Department of La Moſelle.

Some coal mines are worked in this department (30) in the environs of the communes of Oſtenbach and in the canton of Petelange. The annual product of them may be eſtimated at 100,000 myriagrammes at leaſt. The coal is of a very good quality. It coſts at the mine 9 cents per myriagramme.

Department of the Two Nethes.

This department has no coal mines; but it is ſupplied with

with abundance of coal from the mines in the departments of Jemappes and of the North, by the canal of Bruſſels and by the Scheldt.

Department of the North.

Very important coal mines are worked at Anzin near Valenciennes, at Freſnes, Raiſmes, and Vieux-Condé. There is a very conſiderable one alſo in the commune of Aniche.

The different mines worked in this department furniſh at the leaſt 30,000,000 of myriagrammes. They are of various qualities. Some of them are very good for forging iron; others are preferable for ſtoves; and ſome of an inferior quality are proper for burning lime. The price at the mines differs according to the quality. The mean price of good coal is from 12 to 15 cents per myriagramme. When delivered at the ports of Oſtend, Dunkirk, and Calais, it coſts from 25 to 28, and at Havre from 52 to 55.

The means of conſumption for theſe coals, and particularly for thoſe near Condé and Saint-Amand, are very extenſive towards the north, on account of the navigation of the Scheldt, and of the numerous canals which communicate with that river. So that the products of theſe mines might be conveyed at very little expenſe as far as Ghent, Bruges, Oſtend, Termonde, and Antwerp. They might alſo be circulated in Holland, and be exported by the ports of Oſtend and Dunkirk, ſo as to become as important an object of maritime commerce as the Engliſh coals.

Departmeut of La Nièvre.

Coal mines are worked in the canton of Deciſe (32), and are very productive. The annual product is eſtimated at 1,000,000 of myriagrammes, but may be much increaſed. The quality of theſe coals is in general ſuch that they muſt be ſpeedily employed after they are dug up, as they loſe conſiderably by long expoſure to the air. The price at the mine is from 8 to 10 cents per myriagramme; and delivered at Paris from 10 to 13. They are conveyed on the Loire, the canal of Briare, the Seine, &c.

[To be continued.]

LXII. *Memoir*

LXII. *Memoir on the Stones said to have fallen from the Heavens. Read in the French National Institute by* C. Vauquelin *.

WHILE all Europe refounded with the report of ftones fallen from the heavens, and while philofophers, divided in opinion on this fubject, were forming hypothefes to explain the origin of them, each according to his own manner, Mr. Edward Howard, an able Englifh chemift, was purfuing in filence the only route which could lead to a folution of the problem. He collected fpecimens of ftones which had fallen at different times, procured as much information as poffible refpecting them, compared the phyfical or exterior characters of thefe bodies; and even did more, in fubjecting them to chemical analyfis by means as ingenious as exact.

It refults from his refearches, that the ftones which fell in England, in Italy, in Germany, in the Eaft Indies, and in other places, have all fuch a perfect refemblance that it is almoft impoffible to diftinguifh them from each other; and what renders the fimilitude more perfect and more ftriking is, that they are compofed of the fame principles and nearly in the fame proportions.

Before the laft refults of the labour of Mr. Howard were known in France, I had employed myfelf on the fame object; and I have the fatisfaction to find in his memoir, which has been fince printed, that they perfectly agree with thofe which I had obtained.

I fhould have abftained from any public notice of an object which has been treated of in fo able a manner by the Englifh chemift, if he himfelf had not induced me to do fo during his refidence at Paris; had not the ftones which I analyfed been from another country; and had not the intereft excited by the fubject rendered this repetition excufable.

It is therefore to gratify Mr. Howard, to give, if poffible, more weight to his experiments, and to enable philofophers to place full confidence in them, rather than to offer any thing new, that I publifh this memoir. One of the ftones which I examined was tranfmitted to me by C. Saint-Amans: it fell at Créon, in the parifh of Juliac, on the 24th of July 1790, about nine in the evening. This ftone appeared in the air under the form of a fire-ball, which was vifible in almoft the whole of the fouth of France. A very

* From the *Journal des Mines*, No. 76.

correct

correct account was given of it at that time in the abbé Bertholon's *Journal d'Histoire Naturelle*, together with the proces-verbal of the municipality of the place, which confirmed the fall of this stone.

Another stone was given to me by M. Darcet junior: it fell at Barbotan, near Roquefort, in the month of July 1789. The brother of the late Darcet, curé in the neighbourhood, sent it to him, with the proces-verbal drawn up respecting this extraordinary phænomenon. C. Lomet, who is known to several members of the Institute, was at Agen on the day when this kind of meteor appeared in the atmosphere. The following is the account which he gave me of it:

"It appeared as a very bright fire-ball, the light of which was as pure as that of the sun; it had the size of a common air-balloon, and was long enough visible to throw the inhabitants of the country into the greatest consternation; after which it burst, and disappeared. A few days after, some peasants brought stones, which they said were the result of the fall of the meteor: but at that period they were laughed at. What they said was considered as fables; and those to whom the stones were offered, would not accept of them. The peasants would have now more reason to laugh at philosophers."

The third kind of these stones is that brought from Benares in the East Indies, which fell on the 19th of December 1798, exhibiting the very same phænomena as were observed under similar circumstances in other countries. It was given to me by C. De Drée and by C. Saint-Amans, who brought it from England.

All these stones have a similar appearance, and one might readily believe that they had been detached from the same mass. Their surface is blackish, smooth, and, as it were, varnished by a commencement of fusion. The inside is of a whitish gray colour marked with a greater or less number of brown spots, or spots of a darker gray colour than the rest of the mass. Those, however, found at Benares, and in Yorkshire, are whiter in the interior part than those found in France. There are observed in them white pyrites, the fracture of which is very much lamellated; globules of metallic and ductile iron, some of which weigh 46 English grains; but this iron has a whiter colour, and a greater degree of hardness, than common iron. The cause of this difference will be seen hereafter.

I wished to have been able to subject to a separate anaylsis each of the constituent principles of these stones sensible to the eye: but they are so intimately mixed, that it was impossible to separate them exactly. By patience, however,

 I was

I was able to obtain a sufficient quantity of the globules of iron and of pyrites to ascertain the nature of them.

A. A hundred parts of the stones of Benares, pulverized in a mortar of hard stone, and sifted through a fine silk sieve to separate the coarsest particles of the iron which cannot be pulverized, were treated with dilute nitric acid. During this operation there was disengaged a large quantity of nitrous gas; the acid assumed a yellowish green colour; the stony powder became whitish, and, dividing itself, increased considerably in volume, so that it resembled gelatinous silex. Sulphureous particles were observed floating at the surface of the liquor.

B. When the action of the nitric acid ceased, water was added to the mixture; the liquor being filtered, the undissolved matter was washed, and after desiccation in the open air it weighed no more than 64 parts.

C. As the matter treated in this manner was still slightly coloured, it was boiled with muriatic acid, which, as is well known, unites more easily with oxidated iron: it assumed also a greenish yellow colour, and the powder became much whiter. After this second operation the stone, when washed and calcined in a platina crucible, weighed only 47 parts.

D. The nitric and muriatic acids which had been successively poured over the stone as above mentioned were mixed together and then precipitated by ammonia, of which an excess was added. Being heated for some time, the liquor was filtered, and the precipitate was washed and calcined: it had a brown colour, and weighed 38 parts.

E. The ammoniacal liquor had a slight blue colour inclining to violet. Alkaline carbonates produced in it no precipitate; on the other hand, caustic alkalies formed a white precipitate very abundant, but the liquor lost none of its violet colour. This precipitate, when washed and dried in the air, had a greenish shade, and weighed 18 parts; calcination reduced it to 13. This matter readily combined with sulphuric acid, and the result was a solution, which by spontaneous evaporation produced prismatic crystals resembling in taste and savour those of the sulphate of magnesia. It however had a slight greenish colour, and at the end of some minutes produced in the mouth a metallic savour. To know whether the colour and savour of the sulphate of magnesia arose from some metallic substances it was dissolved in water, and hydrosulphuret of ammonia being poured over it, a pretty voluminous black precipitate was produced. After washing and desiccation, however, it weighed only two parts. We shall return hereafter to this matter.

F. The

F. The ammoniacal liquor, from which the magnefia had been feparated by means of cauftic potafh, was mixed with a folution of fulphurated hydrogen. By this mixture there was formed a very voluminous black precipitate, which when wafhed and dried weighed feven parts. This part being united with the three parts obtained alfo by fulphate of magnefia, and kept at a red heat for fome minutes, exhaled the odour of fulphureous acid, and acquired a very dark green colour inclining to brown: the whole then weighed fcarcely three parts.

A fmall quantity of this matter fufed with borax gave glafs of a hyacinth colour; put into fulphuric acid diluted with water, it diffolved only in part, and a fmall quantity which had a metallic appearance refufed to combine with it; but the addition of a few drops of nitric acid, by oxidating it, favoured its folution: by fpontaneous evaporation it furnifhed elongated cryftals of a very beautiful green colour.

By the properties which this matter exhibited it is evident that it was nothing elfe but oxide of nickel; for it is the only one among the metals which poffeffes the property of colouring borax of a hyacinth red colour by fufion, of giving to ammonia a purplifh blue colour, of forming with fulphuric acid a prifmatic falt of a green colour, and of producing by its combination with acids and ammonia triple falts which are not precipitated by fixed alkalies.

An examination of the principles fucceffively obtained by the different means employed for analyfing the ftone of Benares, proves that it is compofed of filex, magnefia, and iron, a part of which appears to be oxidated, nickel and fulphur. Iron, nickel, and fulphur, according to every appearance, form a particular triple combination, which feems only to be interpofed between the earthy parts. I am, however, inclined to believe, that one part at leaft of thefe fubftances is really in combination with the earths; for at the moment when the ftone is attacked by the acids, the filex fhows itfelf in a ftate of very great divifion, and like a kind of jelly. The proportions in which thefe matters are found in the ftone of Benares are nearly as follows:

Silex - - -	48
Oxidated iron - -	38
Magnefia - -	13
Nickel - - -	3
Sulphur an indeterminate quantity	
	102

If

If we might ſuppoſe that the iron contained in this ſtone exiſts in the perfect metallic ſtate, we might eaſily find, by the increaſe of weight which it acquires in conſequence of oxygenation, the proportion of ſulphur; but as it is certain that this metal is oxidated in it in an unknown quantity, that of the ſulphur cannot be determined.

A hundred parts of this ſtone, freed as far as could poſſibly be done from ferruginous matters, were treated with muriatic acid diluted with a little water. The mixture produced immediately, with a ſtrong efferveſcence, a gas which had the odour of ſulphurated hydrogen gas. The matter aſſumed the form of a gelatinous maſs, which ſeems to prove, as already ſaid, that the ſilex exiſts in this ſtone in a ſtate of combination either with iron or with other ſubſtances.

When the efferveſcence had ſubſided, and the mixture had boiled for ſome time, it was diluted with water and filtered. The liquor had a green colour analogous to that of muriate of iron, but a little darker. The reſiduum when waſhed was white, and weighed 49 parts.

The muriatic ſolution and waſhings being united together were precipitated by ammonia added in exceſs, and were ſtirred for ſome time with the precipitate.

It has been remarked, that oxidated iron, precipitated in this manner by ammonia, has a more intenſe colour than that of iron obtained under the ſame circumſtances. This iron, waſhed and dried, weighed 42 parts.

The liquor containing the ſuperabundant ammonia in the precipitation of the iron had acquired a violet colour, which neither the heat nor the contact of the air made it loſe. Alkaline carbonates produced in it no alteration; on the other hand, fixed cauſtic akalies formed in it a white precipitate pretty abundant, which when waſhed and calcined weighed twelve parts. This matter combined with ſulphuric acid gave ſulphate of magneſia, coloured green by a ſmall quantity of nickel which the magneſia had carried down with it.

The liquor from which this earth had been ſeparated by potaſh had loſt a part of its violet colour; it, however, ſtill formed a black precipitate with ſulphurated hydrogen. From what I had before obſerved, I entertained no doubt that the ſubſtance which coloured the magneſia green, and was precipitated black by hodro-ſulphuret of ammonia, was nickel. I therefore ſeparated, by means of this reagent, the portion which remained in ſolution and that which was mixed with the ſulphate of magneſia: I united them, and having calcined them to ſeparate the ſulphur, I obtained a green oxide, which weighed three parts and a half.

The

The method employed to ſeparate the iron and the magneſia is founded on this circumſtance, that a ſolution of that earth containing an exceſs of acid is not precipitated by ammonia, becauſe there is formed a triple ſalt, which cannot be decompoſed by a ſuperabundance of that alkali; but the acid muſt be in ſuch quantity that the ſalt reſulting from its combination with the ammonia may be able to ſaturate the ſalt of magneſia exiſting in the liquor. Care was taken to obſerve this.

Alkaline carbonates produce no precipitation of the ſubſtances which enter into combination with the triple ſalt here mentioned, though it muſt, however, be decompoſed; but there is formed another kind, compoſed of magneſia, carbonic acid, and ammonia, which remains in ſolution. But one thing I did not foreſee was the ſimultaneous precipitation of a portion of nickel and magneſia by the cauſtic potaſh; for, as Mr. Howard remarked, this metal is found there in complex combination, the oxide of which ought to be diſſolved by the ammonia in proportion as it becomes free: the precipitation of this metal muſt be produced by its affinity for magneſia, at leaſt this is what appears moſt probable.

After theſe two analyſes of the ſtone of Benares, and the conformity of the reſults which they furniſhed, though effected by methods ſomewhat different, there can be no doubt that it is really compoſed of iron, ſilex, magneſia, nickel, and ſulphur, as Mr. Howard announced.

Having therefore confirmed by theſe two means, and by others, which it is needleſs to mention, the reſults given by the Engliſh chemiſt in regard to the compoſition of the ſtone of Benares, I ſubjected to ſimilar experiments two other kinds of ſtone which fell in France, in order to aſcertain whether they would furniſh the ſame principles of analyſis as their external characters ſeemed to announce.

To avoid a repetition of the details already given of the analytical methods employed, I ſhall only obſerve, that the ſtones which fell at Barbotan and Juliac, treated with ſulphuric, nitric, muriatic, &c. acids, exhibited in the ſeries of operations to which they were ſubjected, and by the nature of the elements which they furniſhed, the moſt perfect ſimilarity to the preceding. It may therefore be conſidered as fully proved, that the ſtones ſaid to have fallen from the clouds in different countries are compoſed of principles perfectly ſimilar, and conſequently that we muſt have recourſe to a common cauſe to explain their formation, and to ſuppoſe alſo a common ſource from which nature derived the elements of them. I muſt, however, acknowledge, that the ſpecimens

specimens of the stones which have fallen in France are a little more charged with iron than those of other countries; but as this metal exists in them, for the most part, in distinct globules which cannot be pulverized, they could have no influence on the results of the analysis, as the earthy part was sifted through a fine sieve.

All the stones which have fallen to the earth, and particularly in France, contain, as I have already mentioned several times, globules of iron in a metallic state more or less distinct, some of which weigh from forty to sixty English grains. It appeared to me of importance to subject this iron to some analytical trials in order to ascertain the nature of their constituent principles; but before I give the results it may be of utility that I should first give an account of their physical characters. These globules are much whiter than common iron; their colour approaches that of tin; their hardness is also greater, and consequently they are more difficult to be forged.

This metal dissolves easily, and with effervescence, in all those acids which dissolve common iron; but instead of giving pure hydrogen gas, it furnishes hydrogen gas very sensibly sulphurated. A part only of this hydrogen gas, indeed, is combined with the sulphur; for, having made it to pass through water and caustic alkalies, the greater part of this fluid was not dissolved; and after having made the different liquids here mentioned to pass in the same manner, no sensible signs of sulphur were given by reagents; but the water and the alkalies were manifestly hydro-sulphurated, since they then precipitated black the greater part of metallic solutions, and particularly lead. This sulphurated hydrogen gas exhibited to me a phænomenon which, as far as I know, has never been before observed in its combination with water— I mean a very speedy decomposition which it experienced in a flask perfectly closed in which it had been preserved for some days. At the end of that time there were at the bottom of the water a great many small white laminæ, and the water had no odour: it no longer precipitated solutions of lead. This gas then had experienced complete decomposition.

The solution of this iron in muriatic acid was precipitated by ammonia, of which a superabundance was added. The liquor when filtered had a colour inclining to purple; the oxide of iron, when washed and calcined, was of a brown colour, and had sensibly increased in weight. The ammoniacal liquor when subjected to evaporation deposited slight traces of iron, but as long as there was ammonia in excess

it

it retained its blue colour, which, as soon as this free alkali was evaporated, was changed to a meadow green. The liquor constantly preserved this colour, which still acquired greater intensity until complete evaporation, and without forming any deposit, which proves that nickel existed in the combination in the state of a triple salt.

Fixed caustic alkalies occasion no precipitation in this liquor; but they make it resume its blue colour by decomposing the muriate of ammonia and laying bare its base, which then redissolves the nickel.

The hydro-sulphurets formed in it an abundant black deposit; and this was the method employed for obtaining the nickel separate. The hydro-sulphuret of this metal, calcined in a platina crucible, left a powder of a dark meadow-green colour, which had all the properties of oxide of nickel.

The iron contained in the stones which have fallen from the heavens is therefore combined with sulphur and nickel; whence it appears very probable that these two substances, which always present themselves in a quantity more or less considerable in the analysis of the whole stones, arise from a similar combination, which it is impossible, whatever care may be taken, to separate exactly from the earthy parts.

The presence of nickel and of sulphur in this iron explains why it is whiter, harder, and less ductile than common iron.

Though I did not ascertain very exactly the quantities of these substances in the iron, I think I may assert that they do not amount to more than five or six per cent. In regard to the pyrites disseminated here and there throughout these stones, it is formed, as Mr. Howard says, of iron, sulphur, and a small quantity of nickel; but I was not able to ascertain in what proportions these three substances are united, because I had not a sufficient quantity to subject them to an exact analysis.

It appears to result from all the information obtained, and from testimonies worthy of credit, 1st, That masses, sometimes of considerable size, have fallen to the surface of the earth: 2d, That these masses penetrated with fire move in the atmosphere like inflamed balls, which throw light and heat, and to a great distance: 3d, That they seem to have received a motion parallel to the horizon, though they really describe a curve: 4th, That they fall in a state of softness or fusion like paste, as is attested by their varnished surface, and the impressions formed on them by the bodies which they meet with: 5th, That some of them have fallen in England, Germany, Italy, France, and the East Indies: 6th, That all

these ſtones have a reſemblance to each other by their phyſical characters and their chemical compoſition.

What are the cauſes which can produce ſtones of this kind, and communicate to them ſo rapid and ſo ſingular a motion? How comes it they are always penetrated with fire? Theſe are queſtions for which at preſent it would be difficult to aſſign plauſible reaſons.

But whatever theſe cauſes may be, if multiple they muſt be of the ſame nature, ſince all the ſtones which have fallen in countries ſo different have in every reſpect a reſemblance to each other.

Do they owe their origin to volcanoes? But where are theſe volcanoes? We are not yet acquainted with them; and ſtones ſimilar to thoſe in queſtion have never been found among the productions of any of the known volcanoes. Is the atmoſphere the medium in which they are formed? But how can we conceive that ſubſtances ſo heavy as earths and metals could exiſt in ſufficient quantity, and remain long enough ſuſpended in a fluid ſo light as air? If we ſuppoſe that theſe bodies exiſted in the atmoſphere, whence did they originally come, and what means were ſo powerful as to unite them, and to form of them maſſes ſo heavy and ſo voluminous?

The opinion which makes them come from the moon, however extraordinary it may appear, is, perhaps, the leaſt improbable; and if it be true, that no direct proofs can be given of this opinion, it is equally certain that no well-founded reaſoning can be oppoſed to it.

The moſt prudent courſe to be purſued in this ſtate of things is freely to acknowledge, that we are entirely unacquainted with the origin of theſe ſtones, and of the cauſes which produced them.

LXIII. *Conjectures on the Stones which have fallen from the Atmoſphere.* By EUSEBIUS SALVERTE *.

THE antients never entertained any doubt in regard to what they obſerved. As the natural ſciences among them were only collections of facts, no theory compelled them to contradict their obſervations. We accuſe them of often having ſeen without examining; but though we examine better ourſelves, we are often obliged to abjure our ſcepticiſm, and at length to ſee what the antients ſaw before us.

* From the *Annales de Chimie*, No. 133.

Among

Among the phænomena to which this reflection may be applied, there is none more remarkable than the fall of ſtones, produced, according to the antients, by thunder. This is what they called thunder-bolts, an expreſſion long ago baniſhed to the domains of poetry, and which it would appear ought to acquire a place in the language of philoſophy.

The antient hiſtorians all make frequent mention of the production of theſe ſtones. No doubt was entertained reſpecting them in the middle ages; but the difficulty of accounting for them induced us not only to ſuſpend our belief until called forth by more regular obſervation, which was very prudent, but alſo, which was leſs reaſonable, to carry with us in this reſearch a predetermination to ſee nothing, or to deny what we had ſeen.

Notwithſtanding this diſpoſition, inſtances have been ſo multiplied before our eyes, and in ſo uniform a manner, that it becomes difficult not to admit the general fact, whatever opinion may be adopted in regard to the cauſe. Stones abſolutely foreign to the ſoil where they were found, and all having the greateſt reſemblance to each other, have been collected, in Portugal in 1796, in Alſace in , in Yorkſhire in 1796, at Sienna in 1794, at Benares in 1798, in Bohemia in 1753, near Paris in 1768. Several have been found ſtill warm; and uniform tradition ſtates, that they were ſeen to fall from the atmoſphere in the time of lightning, and particularly during the burſting of luminous meteors, the production of which often accompanies ſtorms. The papers of Mr. Howard and of Count Bournon contain very ſatisfactory details in regard to every thing obſerved in regard to the nature and fall of theſe ſtones.

The *Journal de Phyſique, Brumaire, an* xi, contains a memoir of C. Patrin, who, denying the celeſtial origin of theſe ſtones, ſuppoſes that they have only been uncovered and forced from the earth by the contact of thunder. But before this hypotheſis can be eſtabliſhed, would it not be neceſſary that in the places where theſe ſtones have been found, and in others, ſimilar ones ſhould have been previouſly diſcovered at the depth of a foot, or of ſome inches below the ſurface? For why ſhould they ſhow themſelves at the ſurface of the earth only after thunder? Why ſhould they conſtantly eſcape the plough and the ſpade of the farmer, the pick-axe of the ditcher, and the reſearches of the mineralogiſt?

To admit that theſe ſtones have been thrown up into the atmoſphere by volcanoes, ſeems to be attended with the ſame difficulty; for all thoſe analyſed by Vauquelin contain a large proportion of iron and nickel, in the native ſtate, mixed with

 magneſia.

magnesia. But nothing is more rare in the volcanic productions, with which we are acquainted, than magnesia, if we except iron allayed with the nickel in the native state. Besides these stones have been collected at such a distance from all volcanoes, that the power which could so long support and convey through the air such enormous masses, would be still more inexplicable than their spontaneous production.

Chemists have proved, 1st, That these stones, collected in places and at times distant from each other, have a resemblance in regard to the substances of which they are composed, and differ only by the proportions of their elements: 2d, That they differ from all the other mineralogical compounds found at the surface of the globe. It is natural, therefore, to assign to them all an origin of the same kind, and very different from that by which the minerals hitherto observed have been produced.

Struck with these singular characters, C. Delaplace and Biot mentioned, during the discussion which took place in the National Institute in consequence of Vauquelin's analysis, a very bold opinion, but which is rendered probable by the celebrity and character of its authors. According to them, these stones may be the product of a volcanic eruption in the moon. Comparing the mass and density of the moon with that of the earth, and calculating the distance between our planet and its satellite, they have established that a volcanic eruption might project a body to such a distance from the moon as to be within the sphere of the earth's attraction. It is besides proved, by astronomical observation, that the atmosphere of the moon is exceedingly rare, and consequently could oppose very little resistance to the elevation of stones projected from the moon. To this may be added, that as the moon has scarcely any atmosphere, this circumstance may serve to explain why the metals contained in these stones are not in the state of oxide.

But the same observation which has discovered volcanoes in the moon, shews them in a state of luminous ignition, and hitherto luminous ignition has never been known to take place without oxygen. All the gases absorb caloric, and on becoming concrete, suffer it to escape. Oxygen alone possesses the property of absorbing light, and of emitting it when it combines with bodies during combustion. It thence follows, 1st, That metallic substances projected from the moon ought to be oxidated, at least in great part; 2d, That the observations which prove the great tenuity or little extent of the atmosphere of the moon, ought to induce us to believe

believe that the volcanoes which burn at its ſurface are in a ſtate of tranquil inflammation, maintained by a very thin ſtratum of atmoſpheric air, very different from that of our volcanoes in a ſtate of eruption; and, conſequently, that they cannot be endowed with a very ſtrong projectile force: for on the earth this force is produced by the expanſibility of gas compreſſed by the weight of the atmoſphere. But gaſes diſengaged from the lunar volcanoes ought to expand without any obſtacle, and without any exploſion where there is ſcarcely any atmoſphere. Beſides, the exiſtence of theſe gaſes is doubtful, ſince their production would ſoon have formed around the moon an atmoſphere of greater denſity and extent, which is contrary to obſervation. This explanation therefore muſt be abandoned, or we ſhould be forced to admit a ſeries of phænomena, not only foreign but contrary to what we daily obſerve: a ſolution more ſimple, and deduced from facts, which daily take place before our eyes, will perhaps appear more proper for ſolving the problem. It is well known that there are no metals which may not be volatilized by heat: it is known alſo that hydrogen gas exerciſes its diſſolving power on charcoal, iron, and the moſt fixed ſubſtances. If we ſuppoſe that, during the burning proceſs of volcanoes, or the leſs perceptible but more aſſiduous proceſs of the decompoſition of organic bodies, iron and nickel are ſublimated by heat and elevated with the hydrogen gas which diſſolves them, this gaſeous ſolution will ſoon reach the upper regions of the atmoſphere. There, as I have ſhown, with ſome degree of probability, in my *Conjectures on the Diminution of the Waters, &c.* exiſts, and is continually renewed, a ſtratum of hydrogen produced by the continual decompoſition of the water, and which cauſes the greater part of the phænomena that accompany thunder and the aurora borealis. During ſtorms, that is to ſay, when the equilibrium is reſtored with an exploſion between the electricity of the earth and that of the atmoſphere, what muſt take place? The hydrogen inflames and exhibits ſome of thoſe luminous meteors, the exiſtence of which, according to conſtant tradition, ought, as appears, to precede the formation of ſtones. The gas in burning abandons the metal it has diſſolved, and reduces that which was in the ſtate of oxide. The ſtrong heat produced at this moment fuzes the metal, and molecular attraction collects it into maſſes of greater or leſs ſize, which, when they fall to the earth, retain for ſome time a portion of the caloric developed during their formation. The ſurface only, which, by traverſing the atmoſphere in a ſtate of ignition, may have ab-

ſorbed oxygen, is ſlightly oxidated: the interior part is metal in a native ſtate.

C. Patrin obſerves, in ſupport of his hypotheſis, that the diſcharge of an electric battery, on a fragment of the ſtones found at Benares, produced on it a black trace ſimilar to the black vitrified cruſt with which they were covered. This fact indicates what takes place in the atmoſphere, where theſe ſtones are formed amidſt a very powerful electricity, which produces the vitrification and oxidation of their ſurface.

The ſame author ſays, with Mr. Howard, that, ſince no doubt is now entertained of thunder and the electric fluid being the ſame thing, the idea of a *thunder ſtone* is become ridiculous. Nothing could be more true, if thunder were never any thing more than an electric exploſion: but the French chemiſts, and particularly Fourcroy, have eſtabliſhed that hydrogen acts a conſiderable part in the phænomena by which thunder is accompanied. I am even of opinion that its exiſtence ought to be oftener employed in explaining the varieties which continually render the general phænomenon complex.

The moſt remarkable and moſt common are perhaps thoſe luminous meteors, the aſpect of which is always brilliant and often alarming, and which uniform tradition, at periods and in places very diſtant from each other, aſſign as the cauſe of the ſtones which have fallen from the heavens: whether they ſeem to be confounded with the ſtars, and exhibit to the vulgar eye ſtars thrown from their uſual courſe, or whether they accompany thunder, and increaſe or modify the action of its devouring flames, or whether, under the form of fire balls, they rapidly traverſe the atmoſphere, and approach near enough to us to make us experience a heat proportioned to the vivacity of their light, they muſt be conſidered as the effect of the inflammation of hydrogen gas, either pure or charged with ſubſtances in ſolution, which modify their appearance and products. On theſe principles we may point out the ſuppoſed cauſes of the difference which exiſts between ſtones that have fallen from the atmoſphere at different periods. A very violent ſhock of electricity, or great heat, have produced thoſe which are moſt vitrified: thoſe leſs ſo have been formed by a weaker degree of electricity, and perhaps by ſpontaneous inflammation. Thoſe which contain the largeſt quantity of metal in the native ſtate, are the product of a greater proportion of hydrogen gas. It may be readily conceived, that when the hydrogen gas has been previouſly combined with a great

deal

deal of oxygen, the inflammation muſt be inſtantaneous, and the products very much oxidated, while the ſtrata of hydrogen, almoſt pure, burning only at the ſurface, form durable meteors, the continued inflammation of which gives riſe to very different compounds.

It will perhaps be aſked, how the other ſubſtances, ſuch as ſilex and magneſia, are found in theſe ſtones combined with the metals? I might, in anſwer, mention the height to which earths reduced to an impalpable powder are volatilized by volcanoes, ſo as to be carried away by the winds. I might obſerve, alſo, that magneſia, ſoluble in the hydroſulphurets, is ſoluble alſo, in all probability, in ſulphurated hydrogen. But, as I have nothing as yet except conjectures to offer on this ſubject, I muſt here ſtop. I, however, flatter myſelf that I have done ſome ſervice, by ſhewing that a phænomenon, obſervations of which had been rejected becauſe thought impoſſible, has received, at leaſt in part, a plauſible and natural explanation perfectly rational; and that, when placed beyond a doubt, it will be arranged among thoſe ſeries of facts of which ſcience is compoſed.

That I might not render the hypotheſis complex, I have ſaid nothing of the different gaſes, ſuch as ſulphurated hydrogen, carbonated hydrogen, and carbonous oxide, which muſt be continually conveyed into the regions of the atmoſphere by the decompoſition of bodies. The exiſtence of the firſt of theſe gaſes explains, however, the pyritous ſtate of the iron, and the preſence of ſulphur in ſome one of its parts.

LXIV. *Obſervations on the Decompoſition of the Acetite of Lead, by Zinc in the metallic State. Read in the Society of Pharmacy by* L. ANTHONY PLANCHE*.

IN conſulting the different authors who have treated on the hiſtory of metals, and their chemical action on different bodies, we cannot help conſidering zinc as exceedingly valuable, both on account of its utility in the arts, and the eſſential ſervices which it daily renders to chemiſtry.

C. Fourcroy, who in his *Syſteme des Connoiſſances Chimiques*, has collected the moſt numerous and beſt atteſted facts of this ſcience, has deſcribed all its properties with that clearneſs and method which are peculiar to him.

* From the *Journal de Chimie*, No. 133.

It is therefore not ſo much a new fact that I here preſent as a development of one already known, which, as it forms part of a general theory, deſerves to be particularly noticed as one of the curious phænomena in chemiſtry. But to proceed in order, I think it neceſſary to refer to the work of that celebrated chemiſt already mentioned, where it is ſaid, in the ſixth ſection on metals, under the head Zinc, that

"Zinc, by its ſtrong attraction for oxygen, decompoſes the greater number of ſalts and of metallic ſolutions; and that it precipitates from them the metals under the metallic form by completely unburning them, or under that of oxides leſs oxidated than they were before."

This definition is no doubt juſt, and ſeems to be perfectly complete. It is ſuſceptible, however, of the greateſt development; and particularly in regard to the different phænomena exhibited by zinc in contact with acetite of lead. It is the union of theſe phænomena which forms the principal ſubject of the preſent obſervation, or rather the reſult of the ingenious experiment of Dr. Black, which was communicated to me a few years ago, and to which I have made ſome additions.

Dr. Black put into a glaſs jar, containing about four and a half pints, twelve or fifteen decagrammes of cryſtallized acetite of lead. The jar was filled with water, and the mixture being ſtirred, it was left at reſt for fifteen or twenty minutes, or until the greater part of the ſuperabundant ſalt, after the ſaturation of the liquor, was ſpontaneouſly precipitated. A piece of zinc of an indeterminate weight was then ſuſpended in the ſlightly turbid liquor by means of a hemp or ſilk thread fixed to the cover of the jar, and the veſſel was depoſited in a place where it was not expoſed to be ſhaken. At the end of from twenty to twenty-five days decompoſition was completely effected; the zinc, ſuſpended in the middle of the liquor, become diaphonous, was covered by a kind of very brilliant metallic vegetation, which was often continued to the bottom of the veſſel, and which Dr. Black called the tree of Saturn.

Having had occaſion to repeat this experiment a great number of times, it conducted me to ſeveral obſervations, in conſequence of which I reſolved to make ſome changes in it, which, as they do not alter in any manner the chemical nature of the operation, contribute in a ſingular manner to the beauty of the reſult. Theſe changes chiefly relate to the hemp and ſilk threads, which, being eaſily deſtroyed by remaining in the liquor, muſt neceſſarily ſuffer the zinc to fall, and along with it the new metal which covers them. I

therefore ſubſtituted for theſe threads a piece of braſs wire which appeared to me to unite all the neceſſary conditions, both on account of its ſtrength, and the property it has as containing zinc to exerciſe its attraction on the acetite of lead. A ſecond inconvenience ariſes in ſtrictly following the proceſs above deſcribed. It often happens, when the ſize of the piece of zinc is too large, or when the veſſel is not exactly of the proper form, that the decompoſition takes place with great rapidity; each molecula of the new metal proceeds immediately to the zinc, adheres to it in a confuſed manner, and at the end of two or three days, and ſometimes of twenty-four hours, the cryſtallized portion ſuddenly detaches itſelf and is precipitated to the bottom of the veſſel to give place to a new cryſtallization. The proceſs is then divided into ſeveral periods, which appears to be a matter of indifference in a chemical point of view, but greatly leſſens the intereſt excited by this curious experiment.

I obviated this inconvenience by fixing, in a perpendicular direction, to the lower part of the piece of zinc, the ſame braſs wires twiſted into a ſpiral form, and diſpoſed in ſuch a manner as to be about three centimetres diſtant from the bottom of the veſſel.

By adopting this modification, as each molecula of the zinc formed a portion of the braſs, the ſurface of which was in contact with the ſaturation, it became covered with a great number of ſmall, brilliant, metallic laminæ, diſpoſed at firſt alternately and horizontally, and then croſſing each other in every direction *.

When it is required that the braſs, though covered with metal, ſhould retain the forms it has firſt acquired, it will be proper to diminiſh the quantity of the acetite of lead.

About ſix months ago, I repeated this experiment with common and with diſtilled water, in order that I might examine the products. The reſult of this examination is as follows:

Having ſelected two glaſs jars of equal capacity, I introduced into each four decagrammes of very pure cryſtallized acetite of lead.

The two veſſels having been marked No. I. and II., I poured into the firſt 54 decagrammes of common water, and as much diſtilled water into the ſecond. Theſe quantities

* The configuration of theſe laminæ is ſubject to an infinite variety, which ſeems to depend, 1ſt, On the form and different dimenſions of the veſſel in which the experiment is performed: 2d, And perhaps alſo on regular quantities of the zinc and acetite of lead employed. I have ſeen the laminæ ſometimes circular, ſometimes hexagonal, and ſometimes alſo affecting the figure of a leaf of fern or of oak.

were

were sufficient to fill each jar to the commencement of the neck, the height of which was about three centimetres. I then fixed to two pieces of cork destined to close the mouths of the jars a bit of zinc weighing 22·9456 grammes (six gros) by means of a piece of brass wire exceedingly fine, but of such a length as to allow the metal to be immersed only some millimetres in the solution.

I then adjusted, and luted to the aperture of each vessel, a bent tube, which proceeded under the receiver of a pneumatic tub. These two experiments, begun on the 29th of Thermidor, year 9, the centigrade thermometer being at 14° above zero, exhibited the following phænomena.

Six hours after the apparatus was arranged, the jar No. I. was still somewhat turbid, while that of No. II. was transparent, and the whole superabundant salt, after the saturation of the liquor, was entirely precipitated. At this period the zinc in the second jar was covered with small metallic scales, which could not be perceived in the first.

Next day both liquors were perfectly transparent, and the decomposition seemed to have made equal progress in both vessels. I only remarked, that the interior sides of the jar No. I. were lined with a whitish saline stratum, which extended from the middle of the vessel to the bottom. The small scales adhering to the sides and bottom of the piece of zinc, by increasing in volume, had assumed the form of a leaf of fern in the jar No. I., and was exceedingly delicate in No. II.

I observed also at the upper surface of the bit of zinc a kind of metallic moss *, having that livid aspect which characterizes plates of lead exposed for some time to the contact of the air. The saline stratum of No. I. daily decreased to the eighth, when it entirely disappeared. In the course of these two experiments there was disengaged a very small portion of elastic fluid, which when examined was found to be atmospheric air. The quantity of this air appeared to be more considerable in the apparatus marked No. I.; and this appeared to me to arise from the common water employed, which always contains more or less of it. The remainder of the operation exhibited nothing remarkable but an increase in the volume of the reduced metal until the period of the

* This metallic moss in a tree of Saturn, prepared a year before, was found to be covered by a very fine red powder, which occupied both the surface of the zinc and that of a portion of the undecomposed acetite of lead which covered the horizontal bottom of the glass vessel. I consider this red powder as produced by carburet of iron, from which zinc is never free, and which during the operation has been carried to the state of carbonate.

decompo-

decompofition, which took place in the experiment with diftilled water on the 16th of Fructidor, year 9, and in that with common water on the 24th of the fame month. During the whole time the temperature varied only one or two degrees.

As the refults appeared to be the fame in regard to the reft of the operation, I fhall proceed to examine the experiment made with diftilled water.

1ft, The piece of zinc, weighing 22·9456 grammes before its immerfion in the liquor, was completely freed from all the metal with which it was covered. In this ftate it weighed no more than 15·9345 grammes (4 gros 12 grains). Its furface was covered with a gray pulverulent ftratum, the greater part of which ftill retained its metallic brilliancy, while the other feemed to have undergone a commencement of oxidation. When entirely freed from this ftratum, which could be eafily detached with the finger, and which appeared to me to be nothing but zinc, having its moleculæ in part feparated, it was reduced to the weight of 13·380 grammes (3 gros 37 grains).

2d, The portion of the new metallic alloy, zinc and lead *, arifing from the decompofition of the acetite, was wafhed feveral times in diftilled water. Being fubjected to the action of a good prefs, and then to gradual percuffion on a piece of fteel, it poffeffed greater ductility than lead alone. When dried in clofe veffels, and then expofed to fudden heat in an iron fpoon. a portion of it was fpeedily converted into a greenifh yellow oxide. The other portion, reduced without any addition, furnifhed a fmall metallic button of the weight of 9·0183 grammes (2 gros 38 grains), and containing zinc, but much lefs weight for weight than was contained in the above matter before it was heated.

I muft obferve, that, notwithftanding all the precautions which I took to feparate, either by the help of a prefs and unfized paper, or by deficcation, all the water interpofed between the moleculæ of the metal, I was not able to fucceed. It appears probable, that under this circumftance the fpeedy oxidation of the new metallic alloy was owing, 1ft, To the decompofition of the laft moleculæ of water, which could not be entirely expelled: 2d, To the prefence of the atmofpheric air of the veffels: 3d, To the contact and decompofition of the fame fluid during the fufion of the metal.

* The formation of this metallic alloy agrees with the experiments of Vauquelin, from which it refults, that in feveral cafes, when a metal is precipitated from its folution by another, the precipitated metal partakes in fome degr e of the precipitant. This phænomenon takes place in particular during the precipitation of the white metals by zinc.

Examination

Examination of the Liquor with fome Reagents.

1ft, The liquor taken from the jar was colourlefs and perfectly tranfparent.

2d, It gave a ftrong green tint to blue vegetable colours.

3d, When tried with very pure fulphuric acid it formed no precipitate, which convinced me that it held in folution no lead.

4th, A portion properly evaporated furnifhed fmall cryftals of acetite of zinc in argenteous leaves, which affected no regular form.

5th, Ammonia produced in it a white flaky precipitate, not very abundant. At the moment even of contact there is emitted a ftrong odour of flour pafte, which is fpeedily diffipated by agitation.

6th, This precipitate at the end of fome hours had acquired a femi-gelatinous confiftence, and the addition of a new quantity of alkali rediffolved it in part.

7th, The carbonates of potafh, foda, and ammonia, formed in it white precipitates more or lefs abundant.

8th, Lime water recently prepared precipitated from it the zinc in the ftate of a white oxide, paler and more homogeneous than the preceding.

9th, The precipitate obtained by carbonate of potafh, wafhed feveral times with diftilled water, and carefully dried, was exceedingly white and light.

10th, Being brought into contact with concentrated fulphurous acid, it diffolved in it completely, with a difengagement of carbonic acid, and a total difappearance of the fulphurous odour; which feems to fhow a very great relation between the new falt refulting from this combination and the fulphate of zinc, for the difcovery of which we are indebted to Vauquelin and Fourcroy.

RECAPITULATION.

It refults from thefe facts, 1ft, That the decompofition of the acetite of lead by zinc exhibits feveral phænomena not obferved in that of other falts and metallic folutions by the fame metal.

2d, That diftilled water feems to favour this decompofition, as it is effected in that fluid a third fooner than in common water.

3d, That common water may, however, be preferable in experiments of mere curiofity, as it checks the decompofing action of the zinc, and difpofes the metallic moleculæ to affume that arrangement which is peculiar to them; a phænomenon which agrees with the laws of cryftallization.

I fhall terminate thefe obfervations by propofing to the College

College of Pharmacy to adopt among its experiments, which form a part of its annual public courſe of chemiſtry, the tree of Saturn, as proper for proving in a preciſe manner the ſtrong attraction of zinc for oxygen. This experiment, which is not very expenſive, always ſucceeds, and deſerves a place in mineralogical cabinets along with the tree of Diana.

LXV. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

THE meetings of the 12th and 19th of May were occupied by the reading of a paper, by Mr. Chenevix, on a metallic ſubſtance, of which we have ſpoken in our laſt Number. It was announced to the public by its author as a new ſimple metal *ſui generis*, under the title of *Palladium*, or *new Silver*.

Mr. Chenevix made a number of experiments on this ſubſtance, and found that, in moſt reſpects, it was really different from all the known metallic bodies. In a few, however, it bore ſome reſemblance to platina. But it was not poſſible to conceive that platina could be reduced to the ſpecific gravity of 11·8; could be fuſible at ſo moderate a heat; could combine with ſulphur; could be diſſolved by nitric acid, and be precipitated by green ſulphate of iron. Theſe are the properties mentioned in the printed notice we received laſt month, and which we inſerted in our Journal. Mr. Chenevix found them to be truly ſtated.

Reflecting, however, upon the extraordinary anomalies that happen when ſubſtances are united, it occurred to him that ſome metal might ſo far influence platina as to promote its precipitation by green ſulphate of iron, and be itſelf drawn down along with it. Mercury was the firſt that preſented itſelf to his mind, as the moſt eaſily reduced. He poured a ſolution of green ſulphate of iron into a ſolution of platina: no precipitate. Into a ſolution of muriate of mercury: no precipitate. He mixed the two ſolutions, and a precipitate, exactly reſembling that produced in palladium, immediately enſued. He reduced this precipitate; and, after ſeveral trials, at length ſucceeded in obtaining a ſubſtance exactly ſimilar to palladium. From all his experiments, which are much too numerous for this extract, Mr. Chenevix does not heſitate to pronounce palladium to be a ſcandalous impoſition, and an attempt to defraud the public as well as to diſgrace ſcience.

From ſyntheſis and analyſis it appears that palladium of the ſpecific gravity of 11·5 contains about one-third of mercury; and when of the ſpecific gravity of 12·5, about one-fourth.

fourth. As the quantity of this metal diminifhes, the fpecific gravity increafes; the ductility is lefs; and after 12·5 it begins to be no longer acted upon by nitric acid.

Mr. Chenevix gives many methods for preparing a fubftance fimilar to palladium; but the following is the leaft liable to fail:—Take a certain quantity of platina, reduced from the triple ammoniacal falt, and diffolve it in nitro-muriatic acid: add fomething more than twice the weight of the platina of red oxide of mercury, and take particular care to faturate all excefs of acid: then pour it into a folution, alfo faturated, of green fulphate of iron; heat the mixture, and a black precipitate will be formed after fome time. This precipitate weighs rather more than two and a half the original quantity of the platina; but, expofed to a red heat, a part of the mercury is volatilized. Fufed at a ftronger heat, it yields a metallic button, which in different experiments gives a different fpecific gravity. This experiment is of a very delicate nature, and does not always fucceed; and Mr. Chenevix recommends perfeverance and repeated trials to all who would form palladium. It is not often to be obtained of the exact fpecific gravity announced by the author of the fraudulent advertifement; and the fpecific gravity is not conftantly the fame in all his fpecimens. The difficulty is, to unite a fufficiently large portion of mercury with the platina to produce perfect palladium. It may be obtained by this method as low as 10·5, fometimes as high as 15. Mr. Chenevix mentions fome methods of combining platina and mercury in the dry way, fuch as count Mufhin Pufkin's amalgam fufing with cinnabar, lime, and borax, &c.

He then relates fome experiments upon platina; upon its oxides, which are two, viz. one of 7 the other of 13 per cent. of oxygen; upon the affinities of the oxide for the acid and aromatic falts formed by them. He gives numerous examples of the affinities of metals for each other; and of anomalous precipitations, when two or more metals are prefent in the fame folution. He fays, that the fixation of mercury by platina, together with other facts related in this paper, will tend to make us particularly cautious in pronouncing upon difcoveries of fuppofed new metals, and promote fcepticifm even upon our prefent knowledge. He adduces inftances of the difference that exifts between a folution of platina and a folution of mercury merely mixed, and a folution of thefe metals after they have been united. In the former cafe they are eafily feparated; in the latter there is no method of completely difuniting them. He concludes with a curious ftatement of the approximation of feveral metals and of feveral earths to each other in their chemical properties, which follow

low the direct order of their tendency to enter into saline combination.

The whole of the facts related in this paper are of the highest interest to the science, as they prove to what a degree the properties of simple bodies, hitherto thought to be uncombinable, may be altered when they are united; and show the difficulties that attend our pronouncing as to the simplicity or the composition of any substance, whatever be the character that distinguish it in chemical experiments.

ROYAL SOCIETY OF GÖTTINGEN.

The Mathematical Class of this Society has proposed the following prize question, the prize for which is to be adjudged in the month of November 1803:

As it is of great importance in pyrometric disquisitions as well as in the application of them, and also in making researches in regard to the nature of light and heat, to ascertain the various degrees of heat which different substances, sooner or later, acquire when exposed to the solar rays; and, as little certain information has hitherto been acquired on this subject, the society recommends it to the care and attention of philosophers.

1st, To investigate by nice experiments, and by calculation founded on them, in what manner bodies of different substances, but of the same figure and volume, (globes of an inch diameter will, perhaps, be best for this purpose,) are heated by the solar rays under the same state of the atmosphere, the same intensity of light, and the same initial temperament during each minute of observation, &c.

2d, To determine, either by direct observation, which is chiefly desired, or from the observed law of the increasing heat, to what degree of temperament any body taken at the end of the experiment, that is, when the increase of the heat ceases, would have attained.

The Historical Class has proposed the following question, the prize for which is to be adjudged in the month of November 1804:

As many observations have been carefully made by the old and by modern philosophers, particularly since the 16th century, in regard to meteors; as various ingenious opinions have been given respecting their origin and nature, and the laws to which they are subject; and as many things perhaps occur in these which might be of utility to improve meteorology, or which at least may be worthy of further examination, the society requires a continued accurate history of meteorology from the first attempts of the Greeks and Romans in this kind of study down to the present period.

The society, however, by no means desires that the competitors

petitors will include in it any of thofe opinions of the antient or modern writers which, being founded on fuperftition or ignorance, would excite only difguft. It rather wifhes that they would felect, explain, and examine the opinions of Ariftotle, Theophraftus, Pliny, Seneca and Ptolemy, among the antients, and thofe of the philofophers of the 16th and 18th centuries, particularly Telefius, Patricius, Bruno, lord Bacon, Kepler, Gaffendi, and Defcartes, a knowledge of which may be of ufe to meteorology at prefent: it requires alfo, that the manner in which the obfervations were made, and the inftruments employed, may be briefly defcribed, marking at the fame time the climate. An inquiry may alfo be made refpecting the origin of that opinion, which became fo prevalent, in regard to the influence of the planets on meteors: and, in the laft place, the author may briefly and generally determine how far we can approach nearer to the truth by improving phyfical aftronomy and meteorology.

The prize for each of thefe queftions is fifty ducats, and the memoirs muft be tranfmitted to the fociety before the month of September each year.

GALVANIC SOCIETY, PARIS.

Galvanic facts, in proportion as they are accumulated, afford a hope of the happieft refults being foon obtained from the application of this ftimulus. Thofe which we are here about to detail relate partly to theory and partly to the medical employment of this fluid.

In a late fitting of the Galvanic Society, C. Gautherot mentioned an obfervation made by him anterior to that period, which was both curious in itfelf, and of importance, on account of the inductions that may be drawn from it. As it is neceffary to be known before a proper opinion can be formed of thofe by which it was accompanied, we think it proper to lay before the reader the two following experiments:

Experiment I.

The perfon who performs this experiment places in his mouth the upper ends of two wires of platina, or of any other metal not oxidable, and immediately brings the other two ends into contact with the two extremities of a weak Galvanic apparatus, to afcertain the degree of its influence. When this arrangement has been made, the perfon will experience an effect more or lefs remarkable, according as the tongue is more or lefs exercifed in perceiving the peculiar favour of the Galvanic fluid. But if he places thefe two ends of the platina wires one upon the other without deranging thofe placed in the mouth, he will again experience, though in a weaker degree, the fenfation of the favour.

Experiment

Experiment II.

If the Galvanic apparatus has produced only a *minimum* of effect, which muſt be the caſe, 1ſt, When the apparatus conſiſts of only one ſtory; 2d, When the ſubſtances which compoſe this ſtory are by their nature not much calculated for developing the Galvanic effect, or when they can produce it only in the weakeſt degree; it may happen under both theſe circumſtances that the organ of taſte will not be affected by any ſavour. But in this caſe it will be ſufficient to let the two lower ends of the platina wires reſt for a moment on the two extremities of the apparatus, and then to apply theſe two wires to each other without deranging their extremities, which are placed in the mouth. This new contact will neceſſarily produce a more intenſe effect than the former, and if it be required to increaſe it ſtill further, it may be done by applying alternately the lower ends of the platina wires, firſt to the two extremities of the battery, and then to each other. Theſe repeated contacts will develop the peculiar ſavour of the fluid, which is the certain ſign of its influence.

This ingenious proceſs, then, puts the tongue, that diſpoſable inſtrument, in poſſeſſion of a new *galvanoſcope*, which, as appears to us, will be to Galvaniſm what Volta's condenſer is to electricity, ſince by its means the ſlighteſt ſhades of the Galvanic effect may be detected.

C. Nauche, preſident of the ſociety, in the ſame ſitting communicated ſome facts in regard to the medical application of Galvaniſm in caſes of hemiplegia. It reſults from them, that the means of giving a ſtrong ſtimulus to the parts affected, ſuch as the hand or leg for example, is, to make one of the extremities of the piſe to communicate with the former, and the other extremity with the ſpinal apophyſes of the ſixth and ſeventh cervical vertebræ. If the leg be affected, the foot and twelfth dorſal vertebra muſt be made to communicate with the two extremities of the pile. The vital action will then ſeem to be conveyed as if by undulation to all the muſcular organs in order to reſtore motion.

The preſident obſerved alſo, that in caſes of great extremity, where it is neceſſary to increaſe in an extraordinary degree the excitement of the organic forces, one extremity of the pile muſt be brought into communication with the ſummit of the vertebral column, and the other with the ſpinal apophyſes of the firſt lumbar vertebræ. The patient ſubjected to this experiment will perceive flaſhes, certain ſavours and ſenſations, more or leſs painful, in the ſtomach, in the inteſtinal canal, and in the viſcera of the breaſt and the abdomen. The muſcles of the trunk and thoſe of the extremities will be violently contracted.

A fact no less important, and which he confirmed also, is, that the application of Galvanism increases in a particular manner the action of the parotid, the lachrymal, and maxillary glands, that of the kidneys and of the whole lymphatic system. To produce this action the apparatus must be directed, not to the glandulous organs, but as much as possible to the origin of the nervous trunks which distribute themselves thither.

It may be readily conceived what advantage skilful anatomists may derive from an application of Galvanism to the different systems of the animal economy, especially if to anatomical knowledge they unite a thorough acquaintance with the theory of rational medicine. TOURLET.

LXVI. *Intelligence and Miscellaneous Articles.*

MINING.

THE mines of Cornwall and its neighbourhood now yield so large a part of the metals so valuable to the arts, copper and tin, of all that the world produces of these substances, that the present state, and probable future one of productiveness, is highly interesting to those connected with the useful manufactures.

Tin, though the oldest object of the miner's search in Cornwall, now employs by far the lesser number of hands and amount of capital; the quantity raised of course is much diminished. Generally speaking, the tin mines have not been found to hold their richness to so great a depth beneath the surface as copper seems to do; consequently many, which were highly productive mines of this metal, now are stopped, or are worked to little advantage.

Polgooth, the greatest tin mine now in the world, though it produces large quantities of ore, yet it is attended with so great an expense from its depth, that is understood to pay the adventurers now but very little profit. A report of cobalt being found in this mine has been heard, but we do not know whether it is entitled to credit; we wish it may, but, as far as we have had opportunities of judging of the minerals produced in this district, it does not appear to us probable that these scarcer ones will be found in quantities sufficient to repay any great expense in searching for them. The tin mines in the western part of the county, between Penzance and the Land's End, are doing well for their proprietors in general; and though they have for a few years produced but little, they now are throwing up good quantities of ore.

The

The quality of the metal lately brought to market has been found, we underſtand, much inferior to what it ought to be: this may be accounted for in the following way:—Grain tin particularly has been greatly in demand; in order to get more of the metal under this form the ſmelters have of late applied ores to produce it from, which are generally underſtood not to be ſufficiently free from other metals for this purpoſe, and thus the grain tin, though increaſed in quantity, has been leſs pure: at the ſame time the common tin, being robbed of the better part of the ores from which that has generally been ſmelted, has ſuffered a like degradation in quality. It is to be hoped that the ſmelters will ſee very ſoon their true intereſt in this reſpect, and that the riſk of injuring the trade may no longer be continued for the proſpect of temporary gain.

The quantity of copper produced has not much fluctuated of late, though on the whole it may be expected, unleſs unlooked-for diſcoveries be made, to leſſen; as ſeveral large mines have already ſtopped, the produce not being ſufficient to counterbalance the enormous outgoings their great depth occaſioned. Some other mines that have for many years, and even of late, produced almoſt as much as any in this part of the world, are expected ſoon to be abandoned, partly for the reaſon above ſtated, and partly becauſe they have failed in quantity of ore in the lode or vein. On the other hand, ſome mines have bettered in their proſpects: Dolevath, after having been brought into work at an enormous expenſe, has afforded a courſe of copper of great magnitude, and though the ore is not rich in proportion of metal, yet its quantity is large enough to make this diſcovery highly valuable. Wheal Towan, in St. Agnes, continues its productive ſtate; and Wheal Crowndale, near Taviſtock in Devon, is yielding a great deal of copper ore from a ſmall depth under the ſurface.

Like tin, it has been found that copper is of late inferior in purity to what it was formerly, at leaſt it is aſſerted that the ſheathing of ſhips would a few years ſince remain in uſe a much longer time than any that can now be got will do. This probably ariſes in both metals from the ſame cauſe, from the greatneſs of the demand, which tempts the ſmelter to let improper alloys remain in a certain degree in his metal; but it well becomes them to reflect, whether this may not ſooner than they expect be the means of deſtroying the demand all together, by driving the conſumers to ſome ſubſtitute which may anſwer their purpoſe better. F. P. M. S.

ANTIQUITIES.

M. Grotefend has publiſhed an addition to his explanation

of the Persepolitan Inscriptions. The author thought it necessary to prefix to this memoir an explanation of other larger inscriptions, in order that an opinion may be easier formed of it. In the first place, the alphabet of the wedge-form writing of the first sort has two fundamental strokes, which may be called the bow and the arrow, or rather the chisel and the rule. It appears to have been invented chiefly for lapidary inscriptions. It has no round strokes, and is not only very convenient for that purpose, but very beautiful, on account of its simple and regular composition. The author mentions as particular properties of this alphabet: 1st, The principal strokes of the letters are perpendicular; the horizontal are the accessory strokes. The latter are always on one side, or over the former; only in the letter *g*, there are at the top two wedges which cross each other. 2d, The points of the arrows, or wedges, are always turned to the bottom or to the right, when the characters are written proceeding from the left. This position is natural. 3d, Each letter has no more than three wedges, or two angles, as principal strokes, and at most three accessory strokes; however, when an angle forms the principal stroke, there is at times an accessory stroke on the other side. 4th, The angles and principal wedges are all of an equal height, only that in two letters, *m* and *o*, the middle wedge is shorter, in order to prevent their being confounded with the *t* and the *a*, which are similar. In regard to the transverse, or accessory strokes, one of them is often shortened; or one stroke, which ought to be at the top, is often placed at the side for want of room. 5th, In letters which have only one principal stroke, the transverse strokes are always on one side; where there are two principal strokes, the transverse strokes are in general at the top; where there are three, these accessory strokes are also on the side. 6th, When several transverse strokes are over one or two principal strokes, the latter are shortened that the letter may not pass the line. The alphabet itself is represented under a double point of view; first, according to the composition of the strokes, where they begin by the simplest signs, the wedge with one or two accessory strokes; and then according to the order of the letters of the Zendic alphabet. In the last table of Anquetil the author observed letters which he thinks defective, according to a comparison with the plates of Bruyn and Niebuhr. In the last place, the author remarks, that this wedge alphabet has no resemblance to any of the known alphabets; and that it would be vain to attempt to determine the meaning of the single letters according to their resemblance with the Zendic or other letters: the author, however, finds that the letters which resemble each other in the Pehlvi writing at

Nakschi

Nakschi Rustan, resemble each other also in the wedge writing.

Secondly, What the author observes in regard to the Zendic language may be reduced to the following objects:—1st, The Zendic among the Persian dialects is what the Shanscrit is among the dialects of the Hindus, and has a great resemblance to that language. Neither of them is formed, but they are abundant in words; both have a great many elevated vowels, and, on the other hand, have very harsh combinations of consonants. The two languages have also several things common in the radical words and in the flexions, and are very different from other languages. 2d, The Zendic has a great variety of grammatical forms, and a construction without rules; like the Greek and the German it abounds in compound words. The most important thing in this section is an example of the declension of the noun taken from inscriptions, and which in several parts deviates from the declension of Anquetil. The singular, for example, has in the genitive and dative the termination *âbê*, (Anquetil has *tschao* or *ao*;) the accusative has *o*, (Anquetil has *m*,) *e*, and *etschao*, (instead of the *bio* and *bietscha* in Anquetil.) These differences would be striking did we not reflect, that the two sorts of declination are taken from partial examples, and that we are less acquainted with the Zendic grammar than with its dictionary.

ASTRONOMY.

Table of the geocentric motion of the two new planets for June 1803.

	Geocentric Motion of Pallas.		Geocentric Motion of Ceres Ferdinandea.	
	Right Ascension.	Declin. North.	Right Ascension.	Declin. South.
June 2	19h 7m 13s	26° 2′	18h 45m 0s	22° 29′
5	19 5 27	26 16	18 43 2	22 43
7	19 3 30	26 31	18 40 57	22 56
11	19 1 23	26 45	18 38 44	23 5
14	18 59 3	27 0	18 36 27	23 12
17	18 56 35	27 14	18 34 6	23 16
20	18 53 56	27 29	18 31 38	23 19
23	18 51 14	27 43	18 29 9	23 18
26	18 48 22	27 56	18 26 37	23 16
29	18 45 29	28 9	18 24 6	23 0

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END OF THE FIFTEENTH VOLUME.

TO THE BOOKBINDER.

In binding up complete ſets place the Heads at the beginning of the Volumes in the following order: Vol. I. Lavoiſier; Vol. II. A. G. Kæſtner; Vol. III. Bergman; Vol. IV. Boſcovich; Vol. V. Doctor Black; Vol. VI. Fixlmilner; Vol. VII. Beauchamp; Vol. VIII. Sir Joſeph Banks; Vol. IX. Count Rumford; Vol. X. Dr. Robiſon; and the other Heads at the beginning of the volumes in which they reſpectively occur.

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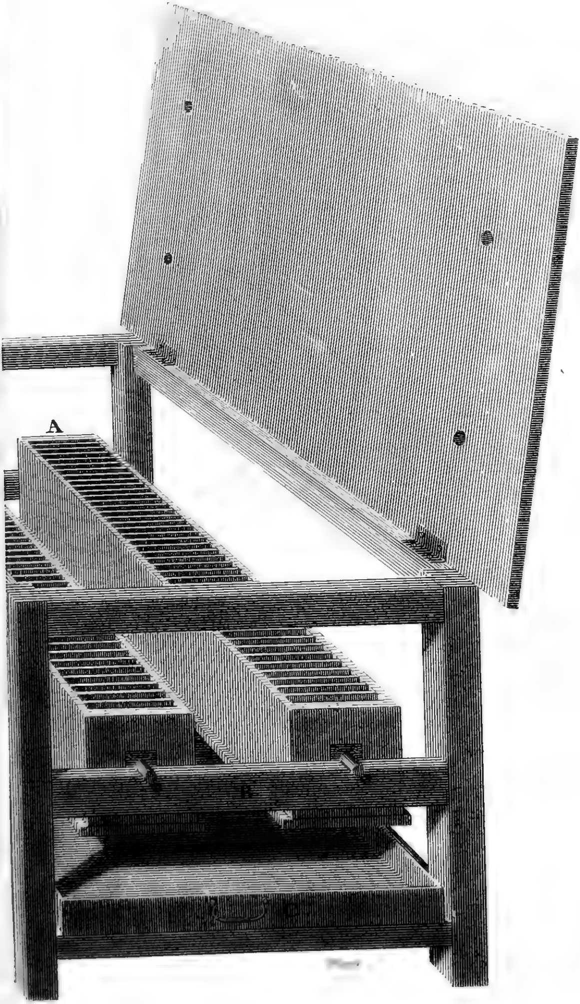

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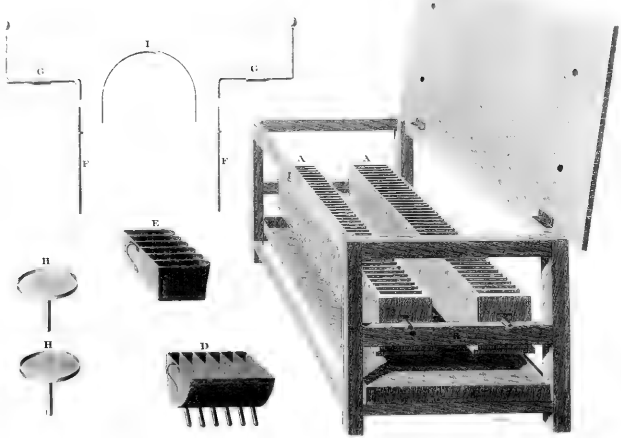

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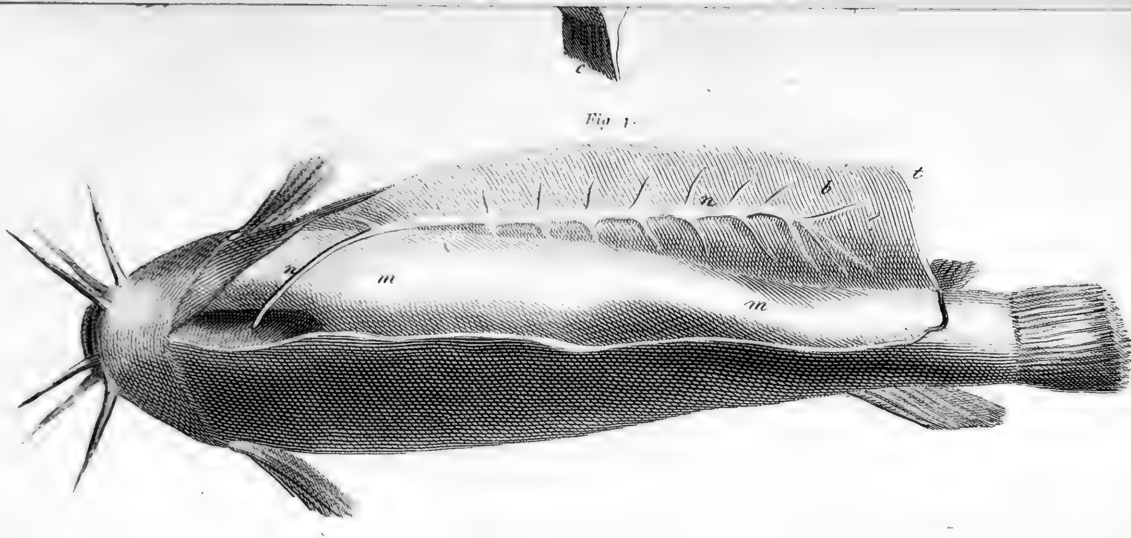

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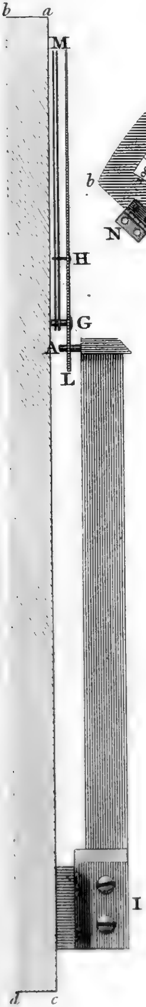

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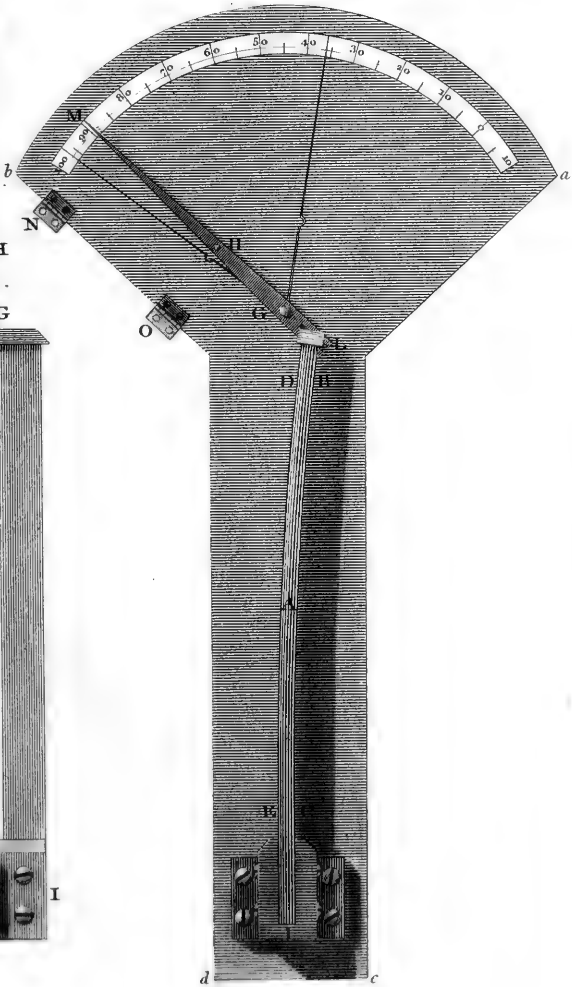

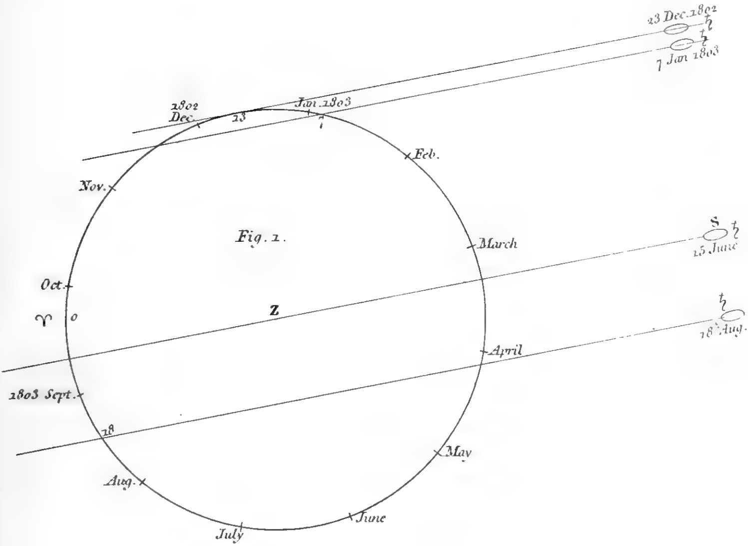
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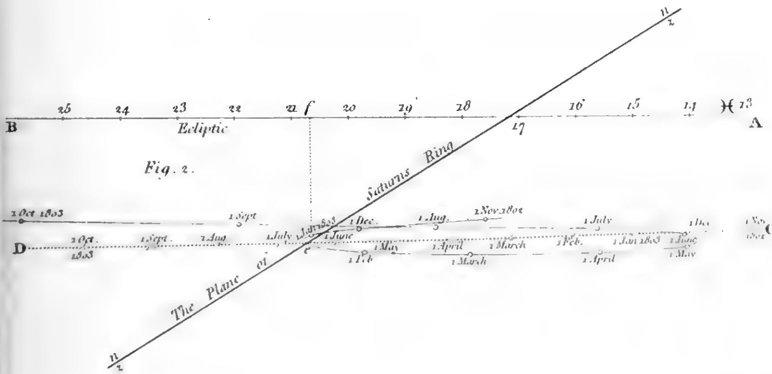
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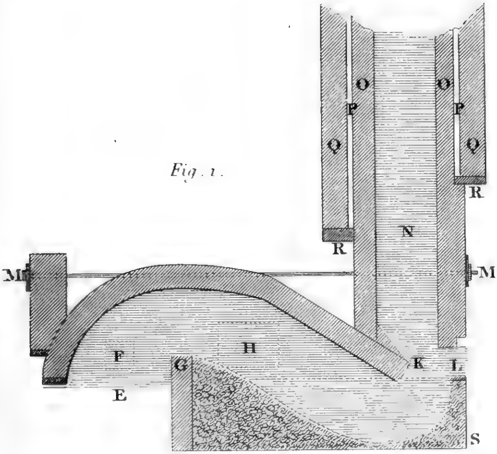

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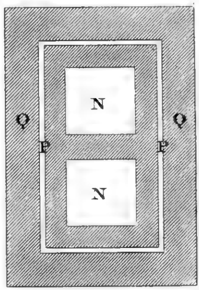

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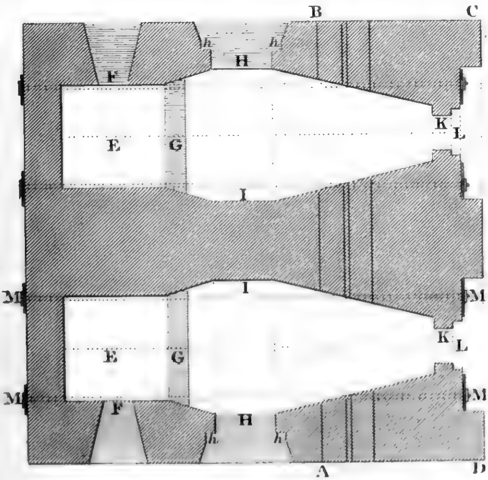

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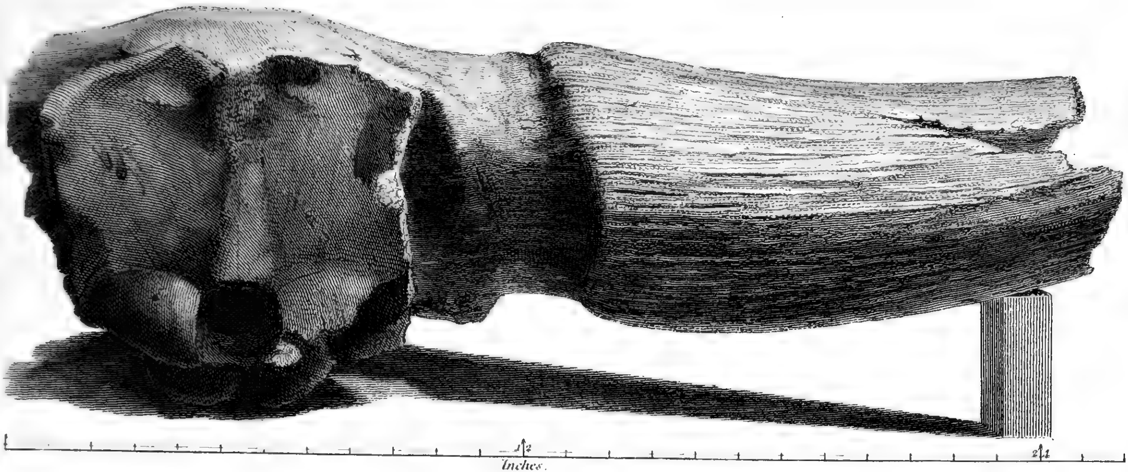

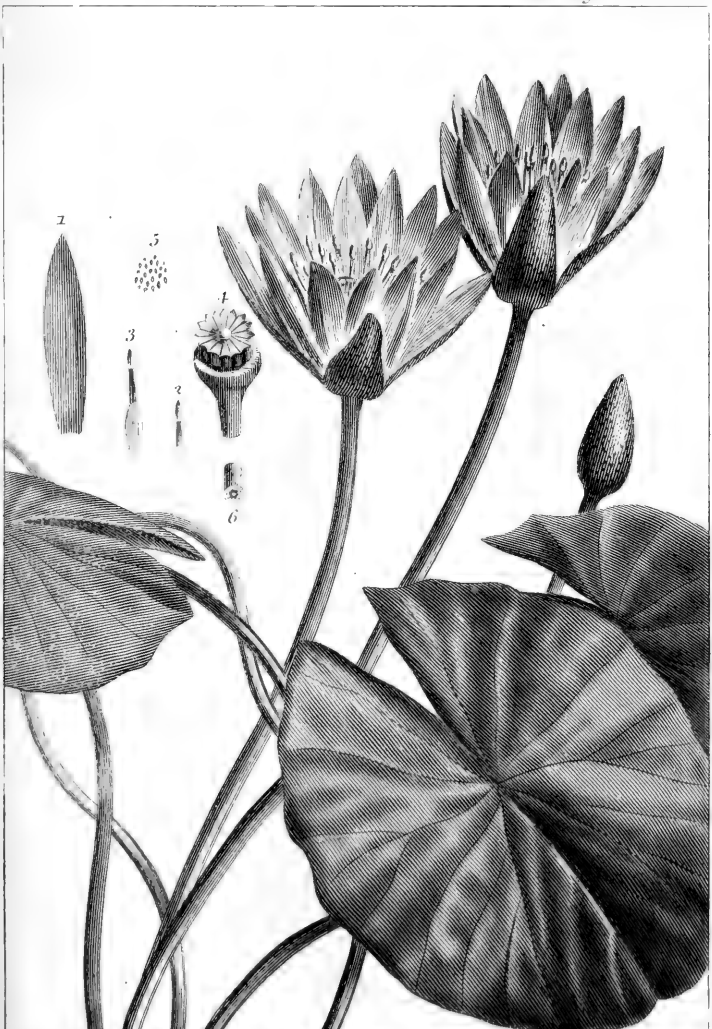

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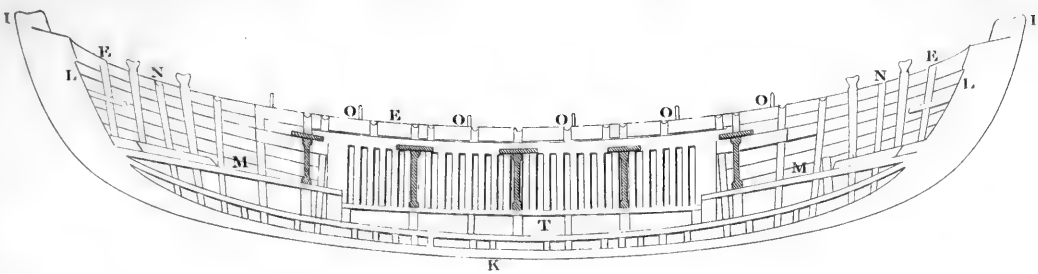
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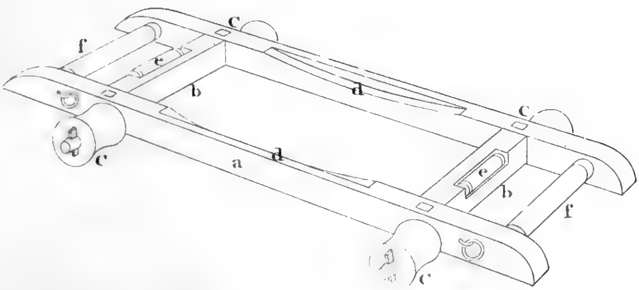
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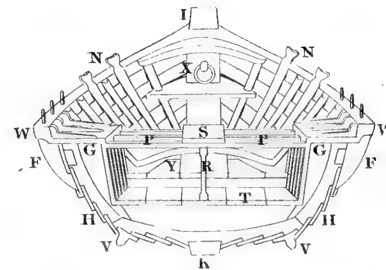
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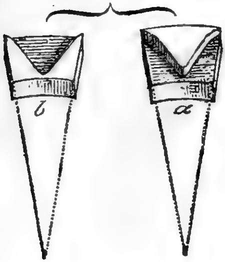

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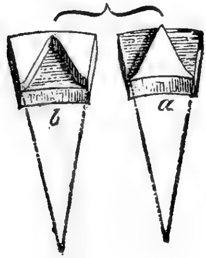

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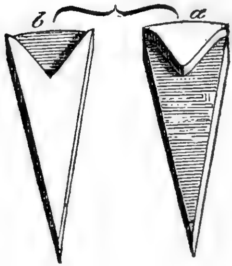

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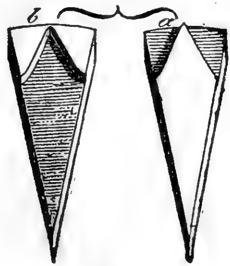

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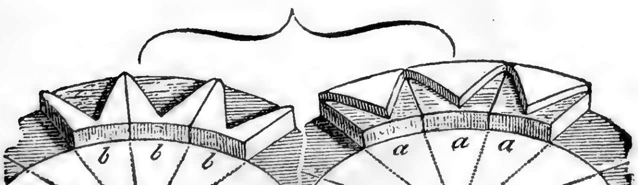

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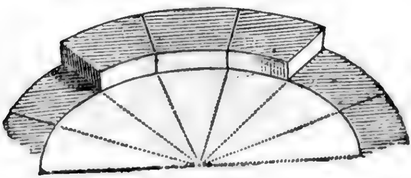

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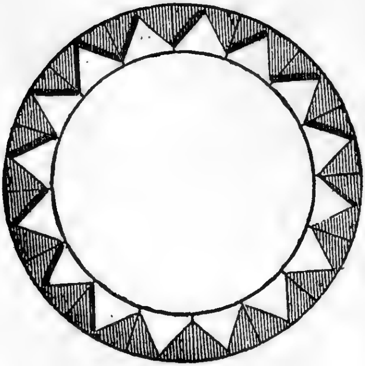

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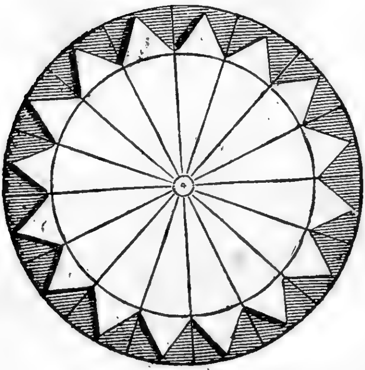

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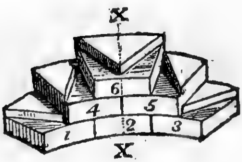

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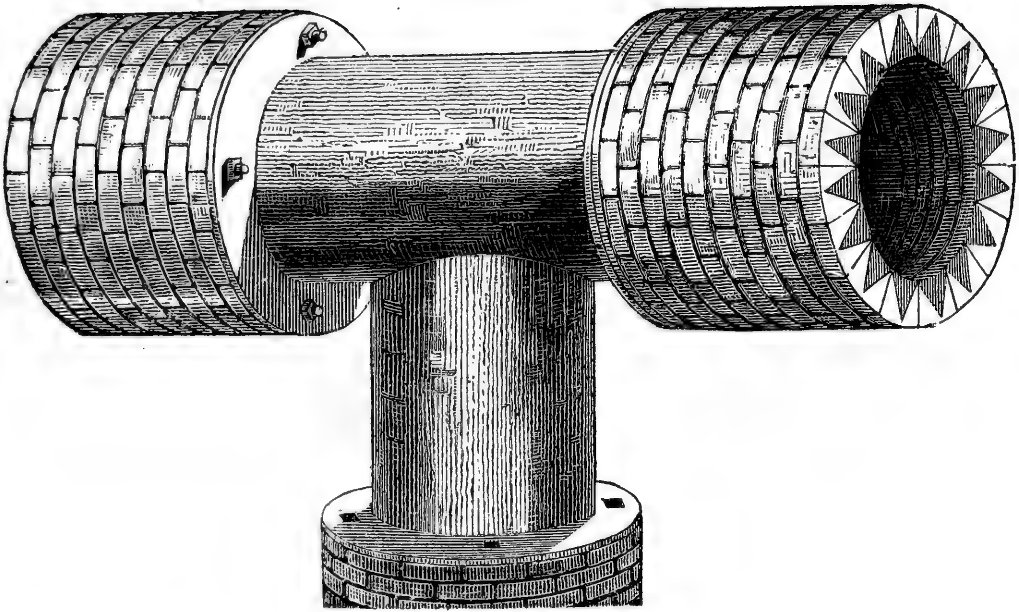

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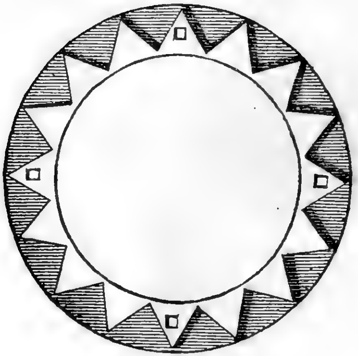

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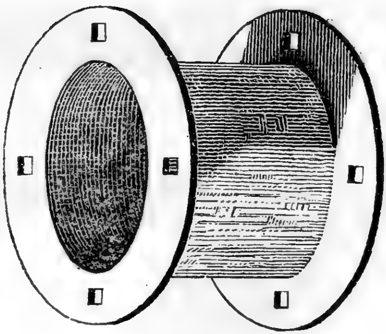

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